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Hot Panel and Hot Floor Border System of Heating

BY CAPT. H. RIALL SANKEY, R. E.

A study of the hot panel and hot floor border system of heating, coupled with a description of a typical installation, was presented at a recent meeting of the Junior Institution of Engineers in London by Capt. H. Riall Sankey, R. E., M. Inst. C. E., designer of this particular installation. The system itself was originally devised by A. H. Barker. Its dominant feature is the use of radiant heat rather than the heating of the air. The principal portions of Capt. Sankey's remarks are given herewith.

It is a platitude to say that the object of warming a building or a room is to make people in it comfortable. Nevertheless, the author thinks the fact has been somewhat lost sight of, possibly because there is no unit of measurement of "comfort," and therefore no condition of fulfilment of this nature which can be inserted in a contractual guarantee. The result has been that most of the systems hitherto adopted have been devised so as to heat the air, and radiant heat has been, to a large extent, neglected, notwithstanding the use of ordinary so-called "radiators." A moment's consideration will show that the design of these radiators is such that only a portion of heating surface radiates heat into the room, and, in fact, the major portion of the heat serves to warm the air by convection.

It is generally conceded that for comfort, when sitting in a room without a fire, an air temperature of about 63° F. (in England) is needed; and, in order to obtain this temperature, the surface of ordinary radiators requires to be at the fairly high temperature of, say, 150° to 180° F., unless a commercially impossible amount of heating surface is provided. This temperature is sufficient to decompose the dust in the air, thus producing a disagreeable and characteristic smell. Moreover, the humidity is reduced unless special precautions are taken, causing, as is well known, a disagreeable sensation; and even a feeling of cold may be produced, due to the rapid evaporation of moisture from the skin.

LOWER TEMPERATURES REQUIRED WITH RADIANT HEAT

When radiant heat from a fire is available, the air temperature can be as low as 55° F., or even 50° F. (in England), and yet the sense of comfort and warmth is greater than in the previous case, i. e., when there is little or no radiant heat. To maintain the temperature at 50° or 55° F., a hot water system of heating, or the like, will be required in many cases; but the temperature of the heating surface can be reduced, and the air is not dried to the same extent. Such a system, although ideal, is more costly; and, moreover, the expense and trouble of laying fires, cleaning out fireplaces, and removal of ashes, which are a serious drawback in the case of large offices, are not obviated.

The hot panel and hot floor system does not unduly heat the air, and it supplies the radiant heat needed for comfort; but before describing this system, it is advisable as a preliminary to refer to certain elementary matters connected with radiant heat.

LAWS REGARDING RADIANT HEAT

According to Stefan's law, a hot body radiates heat in proportion to the fourth power of the absolute temperature of its surface. The amount of heat radiated also depends on the nature of the surface of the body—a characteristic which is called the "emissivity." It can be deduced that if two bodies of the same emissivity are opposed, each having an area of 1 sq. ft., and their absolute temperatures are $t_1 + 461$ and $t_2 + 461$, the amount of heat radiated from the hotter to the colder body will be proportional to $[(t_1 + 461) - (t_2 + 461)^4]$

(The author presented a mathematical discussion of heat radiation between bodies of the same emissivity and of different emissivities, also when the heating surfaces are flat and curved.)

The result is that the hot panel, although of substantially the same surface and considerably less hot, gives three times more radiant heat to the body than the ordinary radiator. This gives some idea of the relative heating surfaces theoretically required for *radiant heat* with ordinary "radiators" at 160° F., and with hot panels at 120° F.

Practically, the matter is much complicated, owing to various considerations. So far, it has been considered that the colder body is only receiving heat *directly* radiated from the hotter body. In a room, however, the heat radiated from the hotter body strikes the floor, the walls, the ceiling, the furniture, etc.; some of this heat is absorbed, but the remainder is reflected in a diffused manner, and some of this reflected radiation strikes the colder body. A similar phenomenon is observed with light, which is reflected from the walls and ceiling, etc. Moreover, the "colder body," represented by an individual, is interchanging heat by radiation with the walls, etc., and if the walls are colder the flow will be from the so-called "colder body" to the walls.

To take an extreme case, suppose that heated air is introduced into a room in which no radiant heat is provided, and let it be supposed that the surface temperature of the walls is 40° F.; then a person, whose surface temperature may be taken as 80° F., will be radiating heat to the walls, and, notwithstanding the fact that the air is warm (say 65°), that person will feel cold. As already pointed out, the heated air entering the room is usually dry, and thus moisture on the skin is evaporated, causing a further cooling of the body. As a matter of experience in Canada, the author has found that when the outside temperature was zero F. and below, unless the air temperature was raised to 80° or 85° F., the room felt cold, because undoubtedly the walls and windows were cold, and considerable radiation took place from the persons to the walls and windows.

The cost of one square foot of panel or hot border heating surface, as compared with one square foot of ordinary radiator heating surface is a commercial matter which it is not proposed to consider here; but it is desirable to know what the ratio between these heating surfaces should be to produce the same degree of comfort—not to maintain the same air temperature—for the reasons already explained.

A glance at Fig. 1 will show that the heating surface of the ordinary "radiator" is not well disposed in respect of providing radiant heat, but the surface not so utilized warms the air, and hence, instead of requiring less heating surface with panels, as indicated by the example given above, in reality about the same amount is required. Only experience can be a guide in this matter, but, as a preliminary, it will be interesting to ascertain the effect of a rule often applied to ordinary "radiators" to find the increase of heating surface when the temperature of that surface is diminished. The rule is that each square foot of the heating surface supplies 1.6 B.T.U. per hour for each degree F. of the difference between its temperature and that of the surrounding objects; that is the heat supply is proportionate to the difference of these temperatures.

From this rule it follows that—

$$\frac{\text{Heating surface at temp. } t_1}{\text{Heating surface at temp. } t_1^1} = \frac{t_1^1 - t_2}{t_1 - t_2}$$

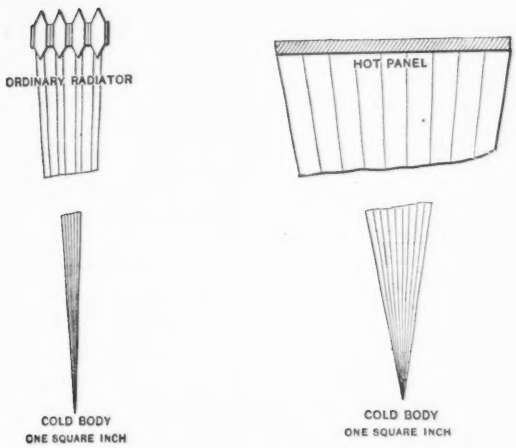


FIG. 1.—DIAGRAM SHOWING HOW ORDINARY RADIATOR COMPARES WITH HOT PANEL IN GIVING OFF RADIANT HEAT.

where t_1 and t^1_1 are the temperatures of the heating surfaces and t_2 is the temperature of the surrounding objects.

To take a numerical example, it is found by applying this rule that the surface equivalent to 100 sq. ft. at 160° F. is 170 sq. ft. when the temperature is 120°, and 262 sq. ft. when it is 100° in each case taking $t_2 = 63°$ F.

In calculating the heating surface for the Royal Liver Buildings, an installation which is described herewith, this formula was used on the supposition that the temperature of the hot panels would be 120° F.; but it has been found that the surface so computed is, in fact, far too great, and experience shows that the temperature need only be 100°.

EFFECTIVENESS OF PANEL HEATING SURFACE

It follows that 170 sq. ft. of panel heating surface at 100° F. is as effective as 262 sq. ft. of ordinary "radiator" surface at the same temperature, that is in the ratio $262/170 = 1.54$ instead of three times, as previously obtained on theoretical grounds for radiant heat only. Further, if the panel temperature were raised to 120° F., the heating surface could be reduced to $170/1.54 = 110$ sq. ft. Hence substantially the same heating surface is required with ordinary "radiators" at 160° F., and hot panels at 120° F.

As is well known, the heat to be supplied by the heating surface is that required to make up for losses by conduction through the walls and for heat carried away by the air needed for ventilation.

In order to maintain an air temperature of 63° F. at a level of 5 ft. from the floor it has been found by experience that the air temperature at the top of the room must be in the neighborhood of 70°. The average is 66.5°, and if the outside temperature is 25°, the difference is 41.5°, and the rate of loss is 41.5 B.T.U. per hour per square foot of glass, 10.4 B.T.U. per square foot of 14-in. brick wall, and so on.

As already pointed out, the same degree of comfort is obtained with hot panel heating with an air temperature of 55°, and it is found by experiment that the temperature at the top of the room is only 60°, or an average temperature of 57.5°. Hence with an outside temperature of 25°, as before the temperature difference is 32.5°, and the ratio of loss is

32.5 B.T.U. per hour per square foot of glass surface.

8.1 B.T.U. per hour per square foot of 14-in. brick wall, and so on.

It will also be seen that the air required for ventilation has to be raised in the first case from 25° to an average of 66.5°, and in the second case to an average of 57.5°, hence the heat losses due to

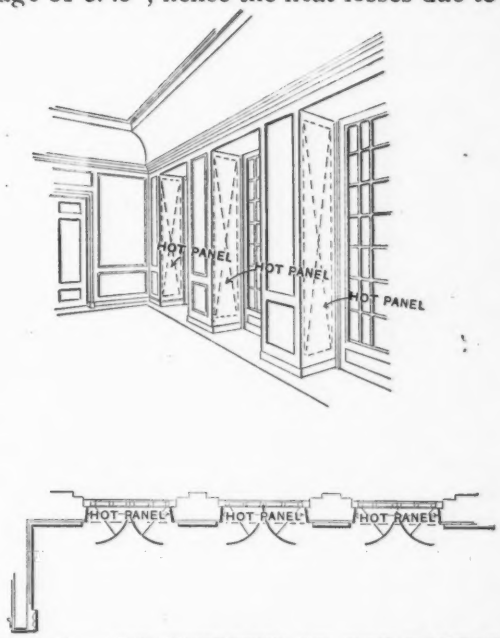


FIG. 2.—ARRANGEMENT OF HOT PANELS IN HOUSE.

change of air are in the first case also proportional to 41.5, whereas in the latter case they are proportional to 32.5, or a saving of 22%. Therefore, the cost of the heating apparatus, namely, boilers, calorifiers and pipe work can be reduced in this proportion; the coal bill will also be reduced in the same proportion.

SAME HEATING SURFACE REQUIRED WITH PANEL SYSTEM AS WITH ORDINARY HOT WATER SYSTEM

To summarize the matter, it may be said that the same heating surface is required with hot panels and hot borders as compared with ordinary hot water "radiators," but that the heating apparatus and the distributing pipe work can be about 20% smaller.

It may be argued that with hot panel heating, which depends principally upon radiation, the losses due to radiation through the windows will be considerable, and that this loss has not been allowed for in the above calculation. But, as is well known, glass, although it transmits bright heat rays readily, is opaque to dark heat rays; they are reflected from its surface.

An interesting example in support of this statement is the case of the heating of a room in an old house where it was undesirable to fix ordinary radiators which would have interfered with the woodwork and the artistic appearance. The jambs of the windows, which were unusually wide, were therefore converted into hot panels, and Fig. 2 shows the arrangement. At first sight a more unlikely arrangement to give good results could hardly be imagined. Nevertheless, the heating of the room was most effective.

A large portion of the radiant heat from the panels striking the walls will, as already stated, be reflected; the remainder will be absorbed and heat the walls, and in course of time the temperature of their surface may reach that of the air. A great deal depends on the nature of the surface of the walls and on their color, and in order to obtain data on the subject the author is at present engaged on a series of experiments.

From the above it will be gathered that, as regards the warmth point of view the comfort of a person in a room depends on complicated interchanges of heat. Heat is received by the person by direct radiation from hot surfaces, and by indirect radiation from these hot surfaces due to reflection and reflection from surrounding objects. The person is losing heat by contact with the air, which is always at a lower temperature than the body, and also by evaporation of moisture from the skin, due to dryness of the air; there is also a loss due to radiation from the body to the surrounding objects. A perfect system of heating requires a skilful combination of all these various interchanges of heat.

CONSTRUCTION OF HOT PANEL SYSTEM.

A hot panel consists essentially of a small pipe bent backwards and forwards and imbedded in a semi-conducting com-

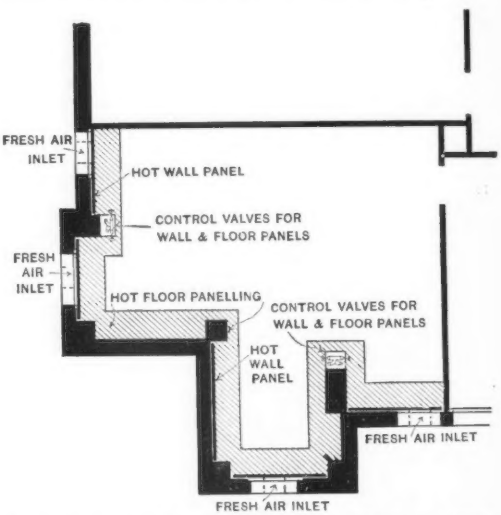


FIG. 3.—ARRANGEMENT OF HOT PANELS AND HOT BORDER IN ROOM.

position; half-inch, drawn, lap-welded steam pipe is used. The heat carrying medium, say hot water, circulates in the tube, and the heat is conducted through the walls of the tube to the composition, through which it spreads to the surface of the panel, whence it is radiated into the room; in effect, heat at a comparatively high temperature issuing from a small surface is converted into the same amount of heat at a lower temperature issuing from a large surface. A hot panel may contain more than one length of tube, in order that the flow in each length may be con-

trolled by external valves. A hot panel can be made up in an iron frame, thus forming a detached unit similar to the ordinary "radiator," or it may be built up against a wall very nearly in the thickness of the plaster.

Hot borders are formed by placing drawn, lap-welded, half-inch pipes about an inch below the level of the floor, close to the walls, around the whole or part of a room, and imbedding these pipes in semi-conducting composition. A hot border of any width desired, say from 6 to 18-in., can thus be formed. This arrangement is specially suitable for passages. Similar pipes can also be imbedded along the cornices of a room. Fig. 3 gives an example of a suitable arrangement of hot panels and hot border for warming a room. Two points of control by means of valves are shown, and four of the panels have spaces behind them, so as to warm the air coming in through the inlets. Fig. 4 is an example of a hot cornice.

In all cases the joints are made by oxy-acetylene welding. With competent workmen this method of making joints has been found to be entirely reliable.

The semi-conducting composition has to be chosen with great care to obviate cracks, which otherwise would be produced by the expansion and contraction of the hot pipes.

The medium carrying the heat from the boilers or calorifiers to the hot panels or hot borders may be either hot water or steam, and the heating apparatus and pipe system is substantially the same as that adopted for ordinary radiators. In very high buildings heated by hot water, difficulties arise with ordinary "radiators" owing to the high pressure of the water at the lower floors; this difficulty does not occur in the system under consideration.

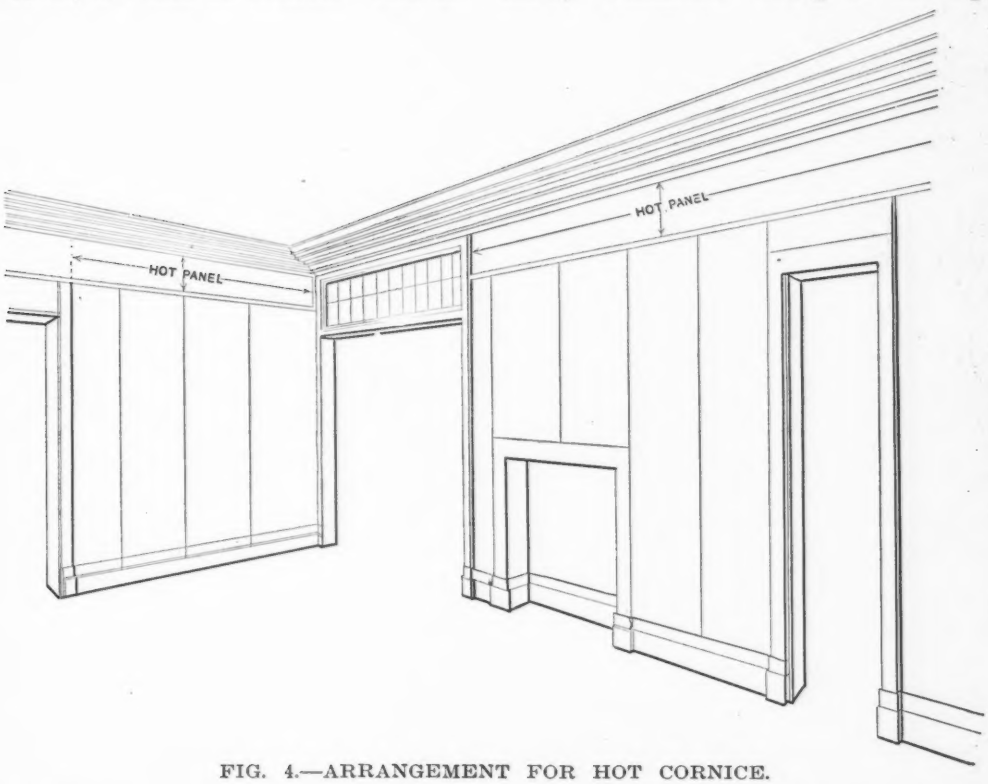


FIG. 4.—ARRANGEMENT FOR HOT CORNICE.

INSTALLATION OF SYSTEM IN ROYAL LIVER BUILDINGS.

As already mentioned, the author had the opportunity of applying the system to a large block of office buildings at Liverpool, known as the Royal Liver Buildings. The installation was completed in 1911, and the heating has been quite satisfactory.

On the external walls, vertical warming panels, constructed as already de-

scribed, are arranged, extending the whole width of the room. The panels are fixed about 1½ in. away from the walls, leaving a space behind, to which fresh air is conveyed through a fresh-air grating fixed in external wall. A shutter with regulating gear is provided to adjust the admission of air. The main wall behind each panel is coated with non-conducting plaster. The panels are so constructed that radiant heat is given off from the front, the side facing the wall being utilized to warm the incoming air. A perforated metal plate is fixed over the top of the air space

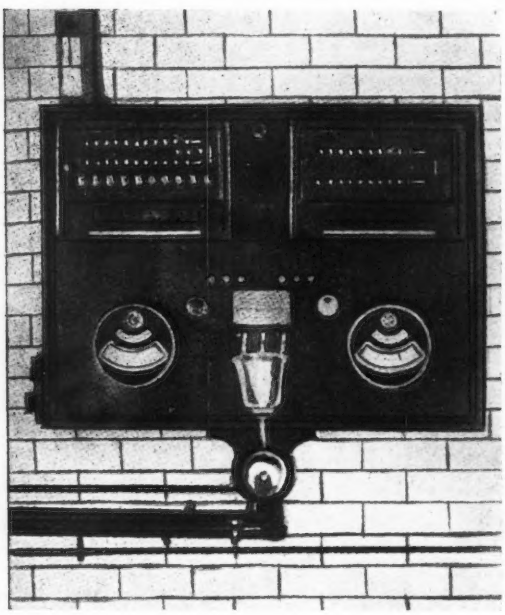


FIG. 5.—CONTROL BOARD FOR HOT PANEL HEATING SYSTEM.

through which the warmed air enters the room.

A narrow warm floor border is formed on two or more sides of each room, according to the exposure of the external walls, and the semi-conducting material covering the pipes in the border is utilized for covering the whole floor, so that a hygienic jointless flooring is provided throughout the whole building. The corridors are warmed by means of 6 in. wide borders formed on each side running the whole length of the corridors.

The panels and floor borders in each room are controlled by independent valves, so that the occupants can regulate the temperature to suit their own requirements.

The warm borders in the corridors are divided up into sections, each similarly controlled. Hot water heated by the exhaust steam from the electricity plant is circulated through the floor and panel coils, and generally a surface temperature of 100° to 110° is maintained.

About 120,000 sq. ft. of radiating surface is provided. The length of ½-in. pipe in the panels and borders is about 50 miles, and there are 19,200 ft. of rising mains, the latter weighing about 60 tons. Altogether, about 30,000 oxy-acetylene welds were made, none of which have leaked. There are 1,200 panel control valves (½ in.), and about 900 multiple way valves.

In order to control the temperature from the calorifier-room, 10 "Barry" thermometers have been placed at certain selected points in the building. There are also two thermometers outside—one on the south, and the other on the north side of the building. Eight thermometers are placed in the flow mains, and two in the returns. The stem of each thermometer, which is of the mercury type, contains a fine resistance wire, connected to a Wheatstone bridge placed in the calorifier room. The resistance of this wire diminishes as the temperature increases, because it is cut out by the rising mercury, and this diminution is measured by the bridge, and indicated, in degrees Fahrenheit, on a dial. The reading on the dial can be adjusted to agree at any time with that of the thermometer by means of a variable resistance. Two dials, mounted on a board, have been provided, one for the room and outside temperatures, and the other for the flow and return hot-water temperatures. The reading of any thermometer can be ascertained by plugging in a "jack" into a hole on the board corresponding to that thermometer. Fig. 5 gives a view of the board. The arrangement has been found to greatly assist in maintaining the desired temperature throughout the building.

As some further examples, it may be stated that certain portions of the new premises recently constructed for the Amalgamated Press in Farringdon Street are warmed on the same system—namely,

the corridors in the editorial department, the main stairs, and also the large hall. The arrangement is generally similar to that at the Royal Liver Building. The main staircase is of marble, with marble linings to the walls. To avoid interfering with the marble work, hot panels have been formed in the frieze, about 12 in. wide, between the top of the marble work and the ceiling, and in one case the ceiling itself has been heated. The diffusion of the heat rays is such that the heating appears to be just as effective as it would be if arranged at a lower level.

At the Midland Adelphi Hotel in Liverpool the carpets are extended over the floor borders. This, however, does not impede the heat rays, and although the temperature of the borders is kept very low, so that the warmth is scarcely perceptible to the hand, sufficient heat is maintained in the coldest weather.

Present Tendencies in the Generation and Distribution of Heat from a Central Station

PLANTS OF THE FUTURE WILL MAKE HEAT THE MAJOR PRODUCT, WITH ELECTRICITY AS A BY-PRODUCT.

BY BYRON T. GIFFORD.

(Read before the Chicago Section, American Society of Mechanical Engineers, April 9, 1913.)

It has long been an accepted fact that from a physical standpoint the art of central heating has been proven to be a feasible proposition. As to the economy of central heating, there are a great many thing to be discussed. The author will endeavor to explain some of the principles he has found to be important and of general interest to all engineers.

Central heating can be likened to any other business. There are three important branches of the work. First, the production of a heat unit which can be compared to any factory in the manufacturing of its product at as low a price as possible. The second branch is the transporting or distribution of this product. In this connection central heating can be compared to any other industrial business in that it is necessary to deliver the manufactured product to the consumer with as little expense as possible. The third point of interest is making the product, or, in our case, the heating service attractive to the consumer.

It is not necessary, perhaps, to wrap up the heating service in a good looking package, but it is necessary to have the heating service attractive to the consumer, both as to price and quality. It is probably needless to mention the reasons why this class of service is so attractive, but it is a fact beyond dispute that every central heating plant that has been built up to the present time, with few exceptions, has had no trouble holding its consumers, because, if the service is once used, no one wants to give it up. It is this one fact, as much as anything else, that has put many heating plants into trouble. They have been tempted to serve a larger territory or more consumers than their plant could economically handle and they have been tempted also to extend their service without due regard to the economies of the proposition.

Referring again to the production of the heat unit, which, of course, is produced in the heating station or power house, there are at present three distinct methods of handling this generation of heat. One is by means of direct firing or what we call "straight fuel burning" plants. The second is an electric generating plant with heating as a by-product, and the third is a combination of a by-product plant, to be used in connection with the heating plant.

IN FUTURE PLANTS HEAT WILL BE MAJOR PRODUCT.

Owing to many causes, it is fast becoming a fact that many of the heating plants built in the future will be of the last type; that is, with heat as the major product, and electricity or some other development as the by-product. In an arrangement of this kind, electricity, for

instance, can be produced at a cost much below that for which the most economical electric plant can produce it. How to dispose of this by-product, electricity, or where to sell it, is a question that is interesting central heating engineers at the present time.

There are, of course, a number of ways of disposing of this by-product. One is to sell it to the existing electric plant at a wholesale rate. Another is to create a market for it by means of creating industries requiring a fairly large amount of electricity at a comparatively low price. One of the properties for which the author is engineer is under contract selling 400 KW. hrs. of electricity to an industry using this electricity twenty hours per day, 365 days per year. The industry pays less than one cent per kilowatt hour for this current.

The net income to the heating company from this by-product is more than sufficient to meet the payments of the bond interest, taxes and insurance on the entire property. I might add, in this connection, that this additional income, amounting to approximately $11,000, is being handled with an increased operating cost of $2,200, as compared with the operation of the plant the year previous when no electric current was generated.

With a simple or a twin Corliss engine, a kilowatt of electricity can be generated under conditions which exist in the average central heating plant with 45 lbs. of steam. Assume, for example, a heating plant serving 200,000 sq. ft. of steam radiation. This load gives a minimum demand on the boilers of 20,000 lbs. of steam per hour and a maximum demand on the boilers of 60,000 lbs. per hour, an average of about 40,000 lbs. per hour. This average load of 40,000 lbs. if sent through a simple or twin Corliss engine, will develop 880 KW. hrs. of electricity.

Assume, for an example, that this electricity is sold to some consumer which might be either the existing electric company or any other industry requiring this amount, for one cent per kilowatt. At this price we would be getting one cent for every 45 lbs. of steam delivered to the heating mains before that steam had left the station, which woud mean approximately 22 cents per 1,000 lbs. of steam. The history of central heating has proven that a rate averaging 60 cents per 1,000 lbs. for steam is reasonable and can be procured from any heating consumer. This would mean, then, that we are receiving 82 cents per 1,000 lbs. for the steam we are generating in our station and at this price it is a conceded fact that a nice return on the investment can be secured.

Heating plants in the United States at present vary in size from a connected load of 10,000 square feet of radiation to a connected load of 1,750,000 sq. ft. of radiation. These plants are built in towns from 1,000 people up. It is not the author's intention to go into details as to how to determine whether or not a heating plant will be financially successful because an explanation of these facts would more than take up the time allotted to this paper.

HEATING PLANTS CAN GENERATE ELECTRICITY AT LOWER COST.

There are, and I believe you will all admit this, very few electric generating plants that can put a kilowatt hour of electricity on their switchboard below a cost of one-half cent per kilowatt hour, and there are also very few electric plants that can generate and distribute to the primary side of their transformers for a cost of one cent per kilowatt hour, especially when the overhead and fixed charges are considered. Heating plants, with electricity as a by-product, can do this and this fact alone is going to develop and make a place for central heating plants where in the past they have been considered unsuccessful. Some of the larger operating companies are doing this at the present time and others are building properties now to operate along the plan described above. I simply mention this point to give you some idea of the possibilities of central station heating.

IMPORTANCE OF LINE LOSSES.

The second point of interest to all heating companies and engineers is the distribution of the heating medium. In water works or in gas properties the losses from distribution consist of leaks and pressure drops due to friction which

are caused by insufficient pipe capacities. In central heating we have these two losses to contend with, and, in addition the loss from radiation, which is called "line loss" by central heating engineers. Leaks are a decided detriment to heating pipe lines and the loss from the source is probably more serious than at first supposed, although this is also true in gas or water systems.

Assume, for an example, a hole ¾-in. in diameter in a pipe line containing steam at 5 lbs. pressure, or assume a number of leaks equal to that size hole. With an evaporation of 7 lbs. of water per pound of coal, we find that this leak will cost us 23 tons of coal per month.

A leak of this size is equally as detrimental in a hot water heating system. The loss from friction affects, of course, the initial pressure to be carried on the heating mains, and, consequently, affects the back pressure to be carried on the engines. As to the value of friction loss, or the detriment of having too high a friction loss, I might mention that in a 3-in. steam line 1,000 ft. long, carrying 1,000 lbs of steam per hour, the friction loss will be equal, under average conditions, to approximately 1,460 B.T.U. per hour. This same load carried 1,000 ft. in a 3½-in. line, will show us a friction loss equal to approximately 500 B.T.U. and a 4-in. line, under the same conditions, will lose only 240 B.T.U. from friction.

The radiation loss from central heating is a very important factor, much more important than friction loss, from the B.T.U. standpoint. There are, as you know, a number of styles of underground insulation in use today, and these insulations lose anywhere from 0.03 lbs. of steam per square foot of underground surface per hour up to 0.38 lbs. per square foot per hour.

HOW TO DETERMINE MOST ECONOMICAL LINE.

In order to determine the most economical line to install it is necessary to combine the friction and radiation losses. In combining these two, some very interesting facts develop.

Assume a demand of 1,000 lbs. of steam per hour, which must be carried 1,000 ft. A 3-in., 3½-in., 4-in. or 4½-in. pipe will do this work nicely, but we must determine the most economical size to use. The loss from friction would be 1,460 B.T.U. per hour on the 3-in. line; 500 B.T.U. per hour on the 3½-in. line; 250 B.T.U. per hour on the 4-in. line and 130 B.T.U. per hour on the 4½-in. line.

Assume a radiation loss of 0.05 lbs. of steam per square foot of underground surface per hour; we find that the radiation loss from the 3-in. line will be approximately 45,000 B.T.U. per hour; a 3½-in. line, approximately 52,000 B.T.U.; 4-in. line, approximately 58,000 B.T.U.; 4½-in. line, approximately 65,000 B.T.U. Combining these two losses we find that the 3-in. line is the most economical to install; provided, of course, it does not affect our heating station conditions by causing excessive back pressure on the engine.

From experience, we have learned that a 3-in. line carrying this load the distance given will have a drop in pressure of about 7 lbs. and as it is necessary to have 1 lb. pressure at the end of the line, it means that our back pressure at the station would be approximately 8 lbs. If this pressure is excessive it would be necessary to run a 3½-in. line, which would give us a back pressure of less than 5 lbs. The difference in cost between a 3-in. and 3½-in. line is comparatively small. The cost of material would be somewhat less for a 3-in. line. The cost of labor would be approximately the same.

IMPORTANCE OF EFFICIENCY IN UNDERGROUND INSULATION.

To show the value in dollars and cents of efficiency in underground insulation, we will compare a piece of line insulated with a construction that will lose 0.05 lbs. of steam per square foot of underground surface per hour to a line insulated with a construction that will lose 0.14 lbs. per square foot per hour. Both constructions are found in everyday practice. For this purpose we will consider an 8-in. line 1,000 ft. long. An 8-in. pipe has 2.25 sq. ft. of surface per lineal foot. In the first case, namely, with a radiation loss of 0.05 lbs., we would have a line loss amounting to 112

lbs. of steam per hour. In the second case, with a radiation loss of 0.14 lbs., we will have a line loss amounting to 315 lbs. of steam per hour. This steam will cost us, we will assume, to generate, 30 cents per 1,000 lbs.

This will show us, in a season's operation (the season considered to be from October 1 to June 1, which is 5,832 hours), a line loss in the first case equal to $195.00 per year and in the second case $550.00 per year. The money saved, therefore, on the line loss will be the difference between $550.00 and $195.00, which is $355.00 per year. This money is 10% on $3,550, which is the amount of additional money we can afford to spend to install the more efficient construction. As the difference between these line losses is 0.09 lbs. of steam per square foot of underground surface per hour, and as the example taken consisted of 1,000 ft. of 8-in. line, which is 2,250 sq. ft. of surface, we see that for every 0.01 lbs. of steam we can save on this 8-in. line, we can afford to spend approximately $400.00, or approximately 20c per square foot of underground surface.

Another example which will probably be of interest is the comparison of two insulations on an entire underground heating installation. This installation consists of approximately 800 ft. of 12-in. pipe line, 1,200 ft. of 10-in. pipe line, 3,600 ft. of 8-in. pipe line, 4,200 ft. of 6-in. pipe line, and 7,300 ft. of 4-in. line and surfaces. The number of square feet of underground surface in the above system is equal to approximately 30,000 sq. ft. Comparing two insulations, one with 0.04 lbs. loss and one with 0.09 lbs. loss, the difference between which is 0.05, we find by a formula which the author has derived, that the more efficient insulation in this case will be worth $30,000 more than the less efficient. The formula used in this connection is as follows.

$$N \times S \times L \times C$$

Where N = the difference between the two insulations in hundredths of a pound of steam lost per hour;

Where S = the number of square feet of surface per lineal foot of pipe;

Where L = the length of the pipe

and Where C is a constant based upon the cost of steam per thousand pounds and the number of hours in the heating season;

Where the steam costs 30c per 1,000 lbs. and the heating season is 5,900 hours, the value of C is 21c, which has been derived as already shown.

As to the attractiveness of the product, or in other words, as to the best method with which to sell the heating service, experience has shown that the meter basis is beyond a doubt the most equitable. Just what rates should be charged is, of course, dependent upon local conditions. A number of companies are selling steam on the meter basis, with a sliding scale rate. Other companies have devised a maximum demand or readiness-to-serve rate, both of which work out admirably well in practice. The quality of the service, as mentioned before, is always sufficiently attractive to obtain a large percentage of the possible consumers.

A City Heating and Ventilating Engineer for Cleveland.

The City of Cleveland, Ohio, has shown its progressiveness by establishing the office of city heating and ventilating engineer.

This office has been made a division of the Department of Buildings and was filled February 24 by the appointment of T. R. Quay, of that city. Under Mr. Quay's direction, inspections will be made as soon as possible (probably next Fall) of the theatres, moving picture shows, schools, etc., with a view of correcting bad ventilating conditions. In the meantime Mr. Quay is revising parts of the city building code dealing with heating and ventilating requirements, examining plans for new buildings, suggesting practical means for ventilation to architects and owners in cases where plans show practically nothing in this connection, and working out the organization of a division of heating and ventilation in such a way as to insure immediate results as soon as the organization is completed.

NEWARK NORMAL SCHOOL, NEWARK, N. J.

Heating and Ventilating Equipment of the Newark Normal School, Newark, N. J.

One of the most recently completed and up-to-date schools in the eastern States is located in Newark, N. J., and is known as the Newark Normal School. The school building consists of three stories and basement comprising about 23 classrooms, an assembly hall, gymnasium, doctor's room, library, study room, demonstration room, kitchen lunchrooms, etc.

Heating throughout the structure is supplied by direct radiation, but a tempered fresh air supply is also furnished to the various rooms. The foul air is removed from all the rooms (excepting the toilets, assembly room and lecture room) by a single exhaust fan located in the pent house on the roof. Each toilet room has a separate vent flue extended up to a ventilator on the roof without connection with any other rooms or vents, while the foul air from the assembly and lecture rooms is carried out through roof ventilators. A general floor plan of the heating system in the basement is given in Fig. 1 and the first floor layout in Fig. 2.

STEAM SUPPLY.

The steam supply is furnished by three 72 in. x 16 ft. horizontal return tubular boilers without domes, set two in a battery and one single. Each boiler has 88 tubes 3½ in. in diameter and

WALL RADIATION UNDER WINDOW SILLS, NEWARK NORMAL SCHOOL.

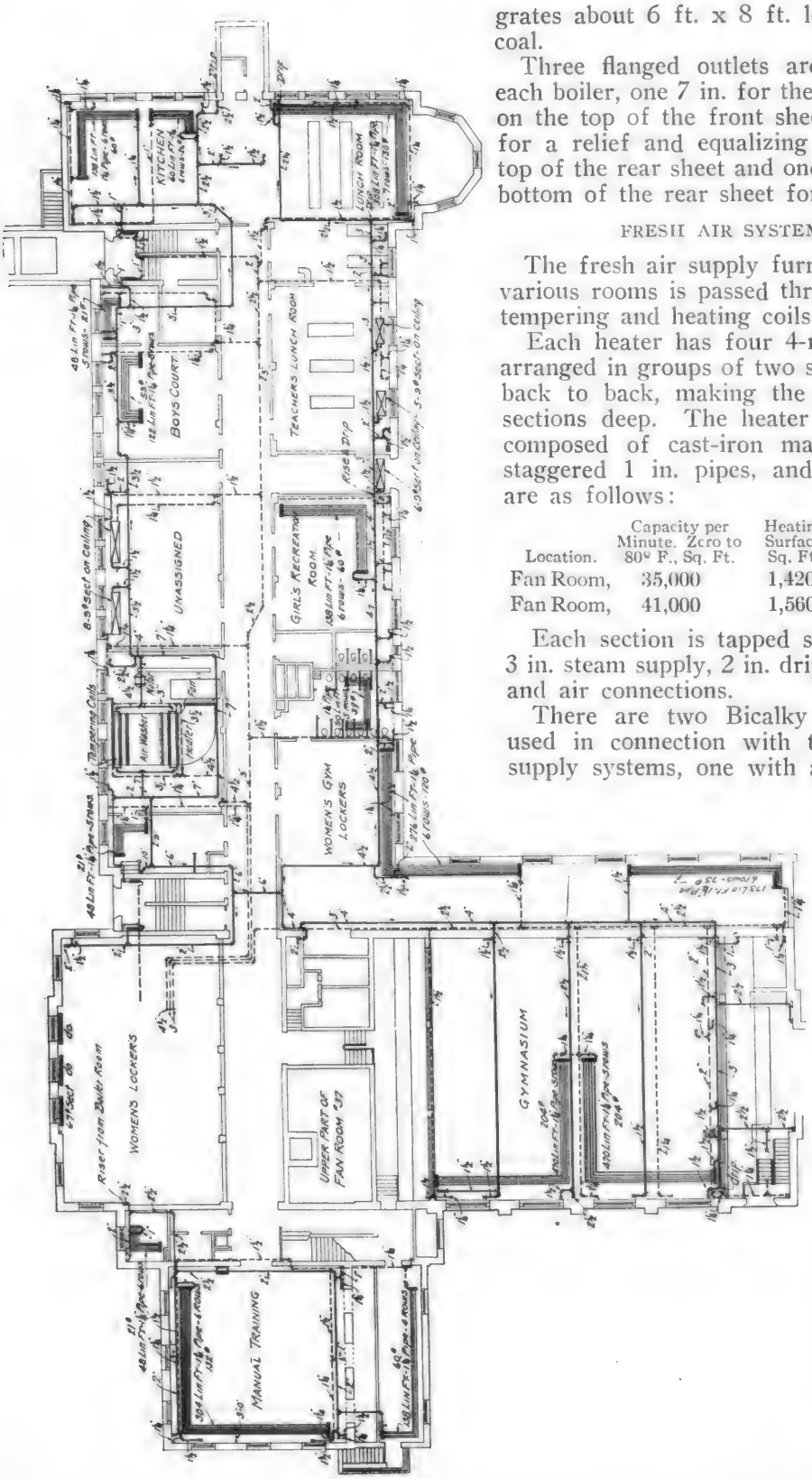


FIG. 1.—BASEMENT HEATING PLAN, NEWARK NORMAL SCHOOL.

grates about 6 ft. x 8 ft. long for pea coal.

Three flanged outlets are placed on each boiler, one 7 in. for the main steam on the top of the front sheet, one 4 in. for a relief and equalizing line on the top of the rear sheet and one 4 in. in the bottom of the rear sheet for the return.

FRESH AIR SYSTEM.

The fresh air supply furnished to the various rooms is passed through sets of tempering and heating coils.

Each heater has four 4-row sections, arranged in groups of two sections each, back to back, making the heaters two sections deep. The heater sections are composed of cast-iron manifolds with staggered 1 in. pipes, and the heaters are as follows:

Location.	Capacity per Minute. Zero to 80° F., Sq. Ft.	Heating Surface. Sq. Ft.	Clear Area. Sq. Ft.	By Pass. Sq. Ft.
Fan Room,	35,000	1,420	29	20
Fan Room,	41,000	1,560	33½	22

Each section is tapped separately for 3 in. steam supply, 2 in. drip and bleeder and air connections.

There are two Bicalky air washers used in connection with the fresh air supply systems, one with a capacity of

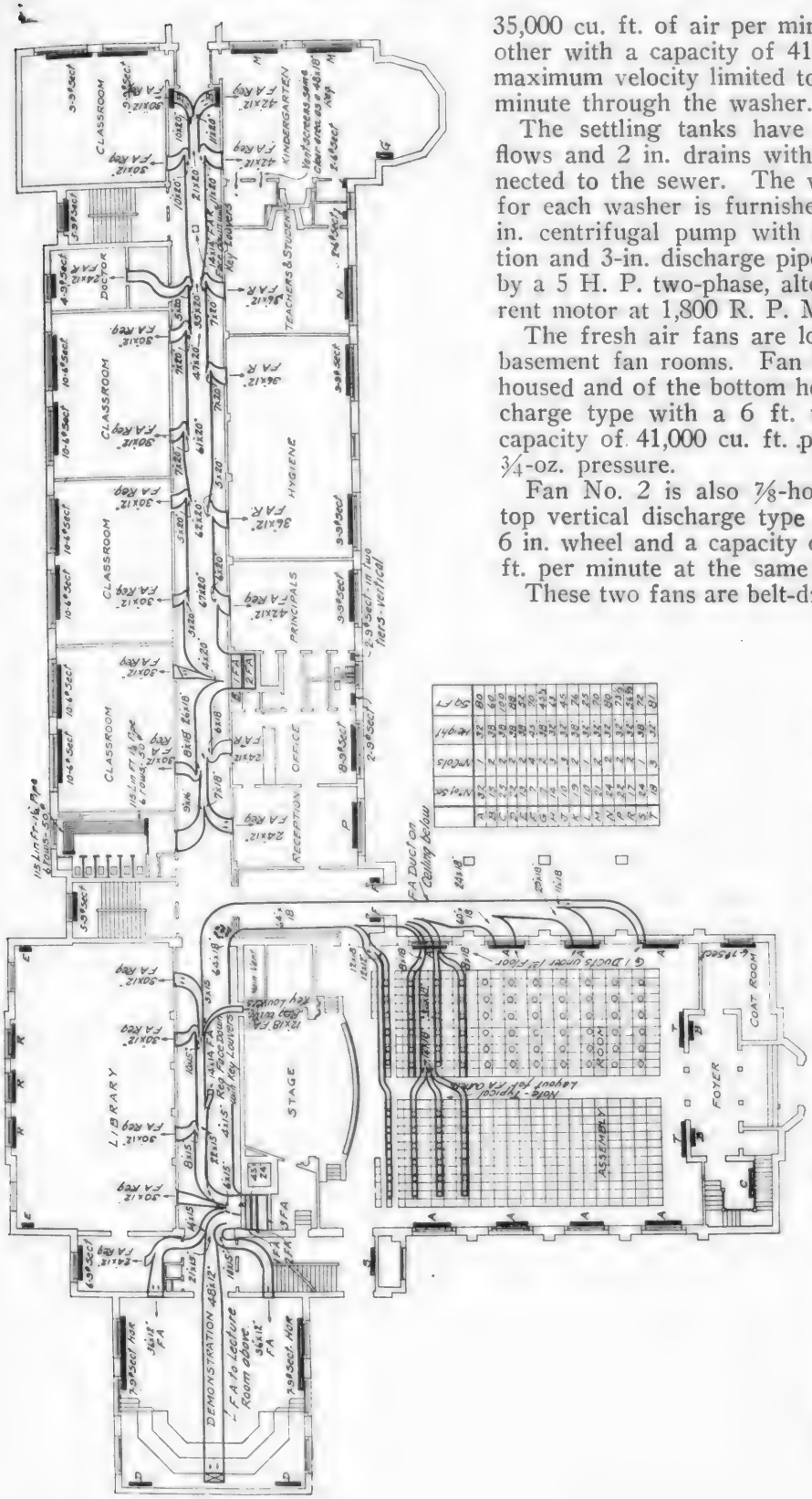


FIG. 2.—FIRST FLOOR HEATING PLAN, NEWARK NORMAL SCHOOL.

35,000 cu. ft. of air per minute and the other with a capacity of 41,000, with a maximum velocity limited to 500 ft. per minute through the washer.

The settling tanks have 2 in. overflows and 2 in. drains with valves connected to the sewer. The water supply for each washer is furnished by a 2½-in. centrifugal pump with a 3-in. suction and 3-in. discharge pipe and driven by a 5 H. P. two-phase, alternating current motor at 1,800 R. P. M.

The fresh air fans are located in the basement fan rooms. Fan No. 1 is ⅞-housed and of the bottom horizontal discharge type with a 6 ft. wheel and a capacity of 41,000 cu. ft. per minute at ¾-oz. pressure.

Fan No. 2 is also ⅞-housed, of the top vertical discharge type with a 5 ft. 6 in. wheel and a capacity of 35,000 cu. ft. per minute at the same pressure.

These two fans are belt-driven by 6 in.

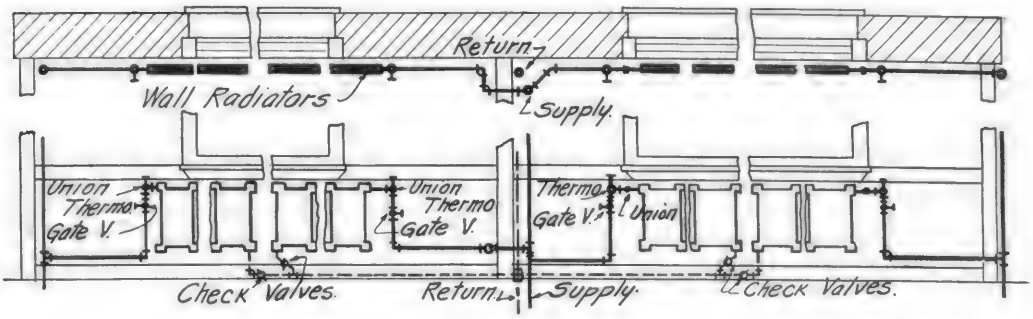


FIG. 3.—TYPICAL INSTALLATION OF RADIATORS AND CONNECTIONS UNDER WINDOWS.

double belts from two 15 H. P. two-phase, alternating current motors running at 1200 R. P. M.

Temperature and humidity control apparatus, of the Standard Temperature Regulation Co. make, is included in the equipment.

EXHAUST SYSTEM.

The foul air removal system is operated by a full-housed top vertical discharge fan with a 6 ft. 6 in. wheel and a capacity of 45,000 cu. ft. per minute located in the pent house on the roof and by a similar fan with a 24 in. wheel and a capacity of 4,300 cu. ft. per minute located in Room No. 11. Both of these fans are driven by belts from motors of 12½ H. P. and 2 H. P., respectively, similar to the motors on the fresh air fans.

The larger fan handles the exhaust from all the rooms except the assembly room, lecture room, and toilets. The foul air is taken out through openings near the floor into ducts run under the corridor floors which are collected into one main vertical duct, which is carried to the large fan and discharged out through the main vent hood located in the roof.

Each toilet has two vent connections with louvered register or damper control, one connection being located near the floor and the other near the breathing plane.

In the boys' toilets and louver connection is made to the opening back of the urinals. These vent connections are collected together and run to the small exhaust fan which discharges the foul air outboard.

The foul air from the assembly and lecture rooms is carried out through roof ventilators.

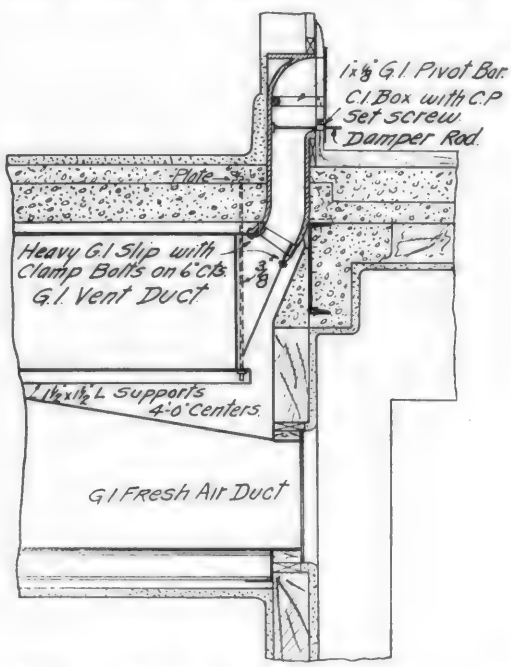


FIG. 4.—TYPICAL CROSS SECTION OF DUCTS IN CORRIDORS AND ROOM CONNECTIONS.

DUCT WORK.

The vertical fresh air ducts are in

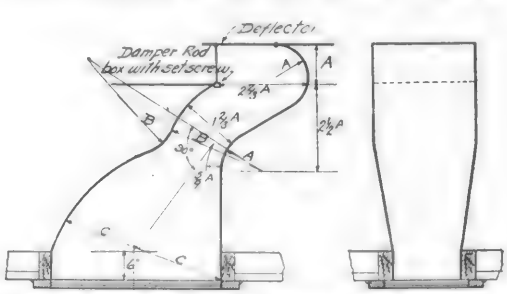


FIG. 5.—TYPICAL CONNECTIONS BETWEEN DUCTS AND ROOM REGISTERS.

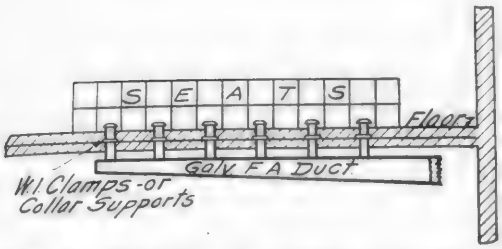


FIG. 6.—METHOD OF CONNECTING FRESH AIR DUCTS UNDER SEATS IN ASSEMBLY ROOM.

general of masonry construction, but the other duct work is of sheet metal. A detail through the corridors showing the inlets into the rooms is given in Fig. 4 and a typical connection for the fresh air inlets is given in Fig. 5.

Details of the method of admitting fresh air to the assembly room is given in Fig. 6 and of the outlets in Fig. 7.

Where register faces are used on the fresh air inlets to the rooms they were of a special design and sizes, furnished by the Best Register Co. of Milwaukee, Wis.

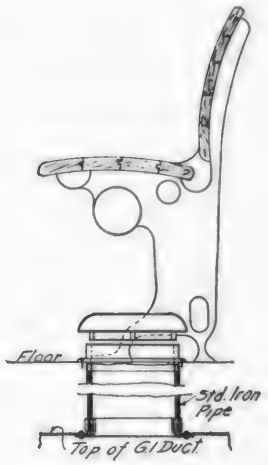
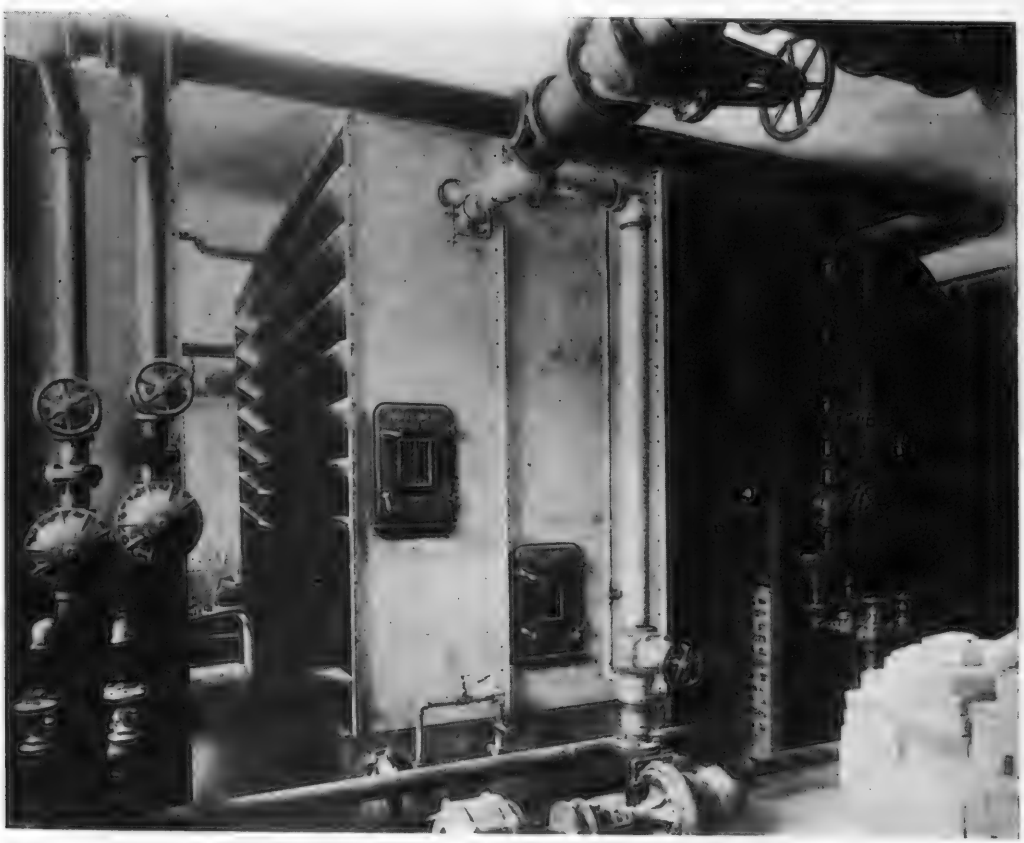


FIG. 7.—DETAIL OF ASSEMBLY ROOM FRESH AIR INLETS UNDER SEATS.

The building was designed and erected under the supervision of the construc-



AIR WASHER AND HEATING COILS IN FAN ROOM, NEWARK NORMAL SCHOOL.

tion department of the Newark Board of Education, E. F. Guilbert, architect, and George W. Knight, engineer. The general contractor is the Herman C. Schneider Building and Construction Co., while the contractors for the heating, ventilating and plumbing work are Storms & Co., Newark, N. J.

Inorganic Contamination of City Air

By Arthur K. Ohmes.

(From a paper read before the Institute of Operating Engineers.)

To supply buildings with fresh air is becoming a more difficult problem in our large cities. Not only are the conditions within the buildings, due to their ever-increasing size, made more difficult, but the sources from which fresh air may be secured are getting less and less. To emphasize this point, consider for instance, the oil-and-gasoline-charged atmosphere created by thousands of automobiles in some of our streets—particularly of our finest street, Fifth avenue, on a typical winter day.

But this is not the only contamination that the city air is subject to, for the smokestacks of large heating and power plants belch objectionable gases and cinders; (smoke is prohibited by ordinance in all large cities), there are the torn-up streets with the disagreable sewer and gas smells.

On dry windy days, we have the dust and dirt from building operations, horse-manure, etc. If it is questionable that the air is healthy at certain times in our streets, what must it be under these conditions in our buildings?

The problem of keeping the air in streets pure, is a matter for health departments and hygienists, but impure street air bears an important relation to the design and operation of ventilating apparatus and must, in the future, be taken more and more into account.

The problem of ventilation is only one and that is to *dilute* the harmful gases, odors, heat, dust, etc., which may all be of various kinds and origin; in other words, the ventilating apparatus should not be expected to *clean* or *help clean* where cleanliness is missing.

In dwellings the most ordinary source of impure air, which should not be expected to be removed by ventilation, is that of bad and unsanitary plumbing with the resulting sewage and disease germs. These should be kept out of the rooms by sanitary plumbing appliances. An active ventilation system will dilute the air, lessen the quantity of disease germs and diminish the risk, but the risk remains too great to be trifled with, and the source of contamination should be removed.

In industrial establishments, factories, etc., we frequently find unhealthy conditions despite the various devices constructed for removing harmful dust, vapors, gases, etc. It is most important to remove harmful dust, vapors and gases directly from the point of origin and dispose of them if possible before they enter the room air which is breathed by the occupants. A ventilating system alone will again dilute any harmful constituents of the air, but can never make them harmless, so cheaply and effectively, as special removal devices can.

This short discussion of the problem of ventilation suggests that two conditions are met, viz.: one being to refresh and renew air in buildings, which are used for living only, and where the air is contaminated by unavoidable sources, being all more or less in the nature of organic contamination; and the other is mostly produced by avoidable sources and in the nature of inorganic contamination.

The organic contaminations of human beings are fairly accurately known, and it is years since the experiments were made to determine them. On the other hand, very little is known at the present time about the ill effects of inorganic contamination. Indeed, very little is known of the point where air mixed with a certain amount and kind of dust or gas becomes harmful.

The field that would be open to the

hygienist who would try to determine the ill effects from them, under the ever-varying conditions, is one that would probably require a life time of study. It would be made more difficult on account of the new manufacturing processes which are created daily. Under this heading should also be included the excessive heat generated by illumination, motor power, boilers, kitchen ranges, laundry machines and engines, which are more or less the result of manufacturing processes. Furthermore, the gases in chemical works and laboratories, and gases and dusts in the many factories where various special goods are manufactured, which may require the use of poisonous and dangerous chemicals, should be included. The ventilation of some of these rooms is becoming almost a specialized field, and is to be divided into two processes; one being the removal of *excessive heat, vapor, gases and dust,* and the other, *ventilation.* Both, of course, should be considered in a problem of this kind at the same time and both belong together.

Solutions of this kind of ventilation are the most difficult and it frequently happens that sufficient and ample means are not provided. Data relative to the removal of this matter vary greatly and the ordinary hygienic standards of figuring ventilation, developed so far, have no value whatsoever.

The heat given out by illumination has been determined frequently and the average results show the following:

	B. T. U. per Candle-power.
Electric arc lights	2 to 6
Electric incandescents	12 to 20
Gas jets	34 to 56
Kerosene lights	150
Wax lights	320

which shows conclusively the value of electric light in the matter of heat generation over the old-fashioned lights.

An electric motor placed in a room causes a heat production of about 2,400 B. T. U. per hour per horse-power, provided that the power is used up entirely within the room.

The dusts created by many manufacturing processes are particularly harmful. Statistics can be found that even the dust created by the cutting of dry stone, dust from saw-mills, from grinding cement, are harmful if continually inhaled. Where, however, in the manufacturing processes, lead compositions are used, the resulting sickness when good ventilation is missing, and the air is partly charged with lead, if frequently breathed, is appalling. In such places the rooms should be high and the dust removed at the point where generated. In addition, a plentiful supply of air for dilution purposes, must be given, so that any dust, that cannot be gathered by the special dust removal devices, will be sufficiently diluted to be practically harmless. It should be insisted upon by law to have dust removal and ventilating plants provided in all such factories, because the dust inhaled is infinitely more dangerous than the respiratory products of man. It is, for instance, over 10 years since the Minister of the Interior of Saxony, at the request of the Medical Society of Saxony, prescribed the most stringent laws as to ventilation, cleanliness, sweeping, washing, clothing, smoking and eating for all workers employed in factories where lead compositions of any kind were used.

It is a source of pride that, particularly in this country, large manufacturing corporations realize this condition more and more, and are therefore installing devices for removing harmful gases and dusts; similarly well treated are the appliances for washing, cleaning, etc.

Of course, philanthropic considerations are often not the only reasons, because it is to the employers' interest to keep employees healthy, as better work can be expected from healthy than from sickly people. The cost of these safeguards is therefore a good investment, conducting to high efficiency of workmanship and good health.

Sometimes it is considered sufficient to have helmets with air cleaning devices for men who must work in dusty places. These helmets are not used frequently—which is no doubt due to their overheating of the head and brain, causing discomfort of breathing, etc.; dust removal devices are preferable on this account.

STEEL SLEEPING CAR EQUIPPED WITH GARLAND EXHAUST VENTILATOR.

Ventilation of Steel Sleeping Cars

Tests showing the superiority of the steel sleeping car from a ventilation standpoint are reported by Thomas R. Crowder, M. D., in a paper presented at the recent International Congress on Hygiene and Demography at Washington. A previous test with wooden cars, made by Dr. Crowder, was published in THE HEATING AND VENTILATING MAGAZINE for December, 1909. In both tests the cars were equipped with the Garland ventilator, a device designed to exhaust the air through certain of the upper windows or deck-sashes by a suction effect dependent on train motion, all other deck-sashes remaining closed.

This arrangement is just the opposite of that ordinarily employed where air is admitted at the top by natural forces through openings provided for that purpose and allowed to find its own way out.

In the experiments with the wooden cars, it was found that each of the exhaust ventilators would remove about 15,000 cu. ft. of air each hour at a 40-mile train speed. Six to eight of them were applied to each car. The results of a large number of observations showed that by the application of this exhaust device, the active ventilation of the body and berths of a sleeping car is considerably increased over what may be expected from the natural forces of the wind through the open deck-sashes, and that a flow of fresh air into the car is more regular and better distributed. The many crevices about doors and windows act as intakes and the trend of the current is, of course, upward. The respiratory contamination of the air of the breathing zone and of the occupied berth remains almost constantly low. Carbon dioxide reaches a proportion of 10 parts in 10,000 of air with relative rarity, and the computed fresh air supply averages about 2,000 cu. ft. per hour for each berth and about 40,000 cu. ft. per hour for the car.

CHANGES IN CONSTRUCTION OF ALL-STEEL SLEEPING CARS.

With the adoption of the all-steel sleeping cars, the exhaust ventilators have been installed during the building and the deck-sashes almost, if not quite omitted, being reduced from twenty-four to four, and these four very small. Electricity only is used for lighting, thus avoiding the necessity of making openings through the roof to carry away the combustion gases of burning lights.

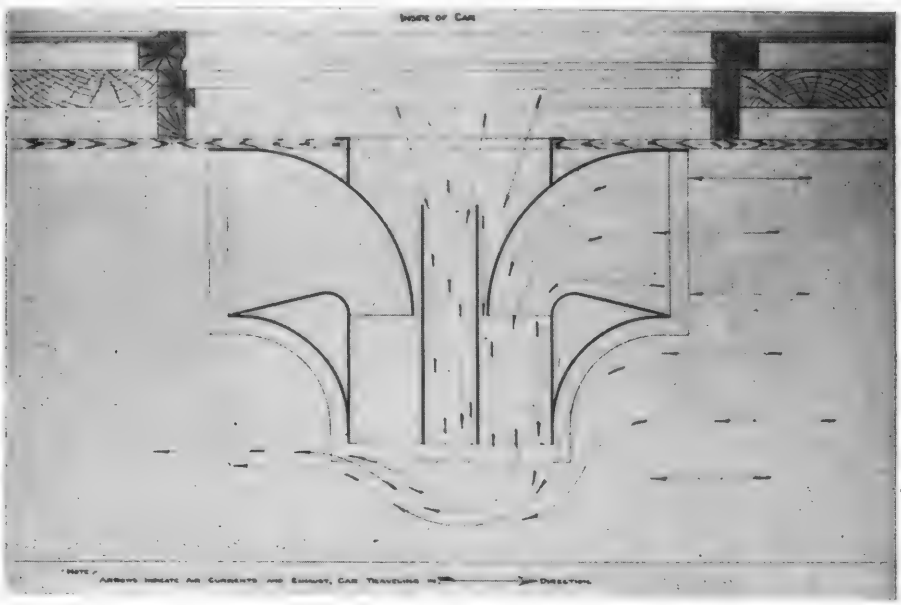
The upper portion of the all-steel car is thus almost entirely free from natural openings, so that whatever air enters these cars must come from crevices about the windows and doors located low down. In order to get some adequate information as to what actually takes place in the cars under these conditions, a series of thirty-six steel cars were investigated during the first two months of 1912.

All observations were made during the night, after the passengers had retired. The outside temperature varied from 0° F. to 36° F., and was generally as low as 20° F. Samples of air were taken as nearly simultaneously as possible in the aisle and in from three to six berths. Samples from the same places were repeated at 15-min. intervals for one or

two hours. The average results in the 36 cars tested were as follows:

Average number of people in car	16.2
Number of tests	246
Co_2 per 10,000 of air.	
Average	5.78
Minimum	4.5
Maximum	9.5
Approximate hourly air supply, cubic feet	54,600

The reading of 54,600 cu. ft. of air supply as the approximate hourly average, computed from the average proportion of Co_2 and the average number of occupants in the 36 cars examined, compares with 40,600 cu. ft. per hour for the older type of car, equipped with the same kind of ventilating device, but maintaining the deck-sash construction, and with 28,300 cu. ft. per hour for cars having the ordinary deck-sash ventilation. The results are also more uniform and more regular.



SECTIONAL PLAN VIEW OF GARLAND EXHAUST VENTILATOR FOR SLEEPING CARS.

COMPARISON OF LOWER AND UPPER BERTHS.

On the basis of 856 carbon dioxide determinations in the air of 126 lower berths in thirty-six steel sleeping cars equipped with exhaust ventilators, the average air supply per berth is found to be approximately 2,170 cu. ft. per hour. This compares with 2,030 cu. ft. for the lower berths of the older type of cars equipped with the same ventilating device, and with 1,390 cu. ft. in cars ventilated by the deck-sash method.

On the basis of 207 carbon dioxide determinations in 30 upper berths of 21 steel sleeping cars equipped with exhaust ventilators, the average air supply per berth is found to be approximately 2,000 cu. ft. per hour. This compares with 1,880 cu. ft. for the upper berths of the older type of cars equipped with the same ventilating device, and with 1,270 cu. ft. in cars ventilated by the deck-sash method.

The upper berth has no window opening into it. The edge of the berth is about on a level with the top of the window. There is a space of about one-half inch between the edge of the berth and the wall—a total open space of about 36 sq. in. Through this wide crevice the upper berth receives much of its air supply, which must then pass inward and upward across the berth and its occupant toward the ventilator exits.

It will be seen that the ventilation of the lower and upper berths is, on the average, much the same. It is relatively

rare for the average air supply of the two to fall far apart. If one is high the other is high; if one is low the other is low. The general averages show results which would indicate that the lower berth receives slightly more air than the upper berth, but the difference is almost trifling.

GENERAL COMPARISONS.

Following are the comparative results for the car body, and the lower and upper berths in the three classes of cars. The general averages of CO_2 and the computed air supplies are as follows:

A. Wood Cars (with Deck-Sash Construction)

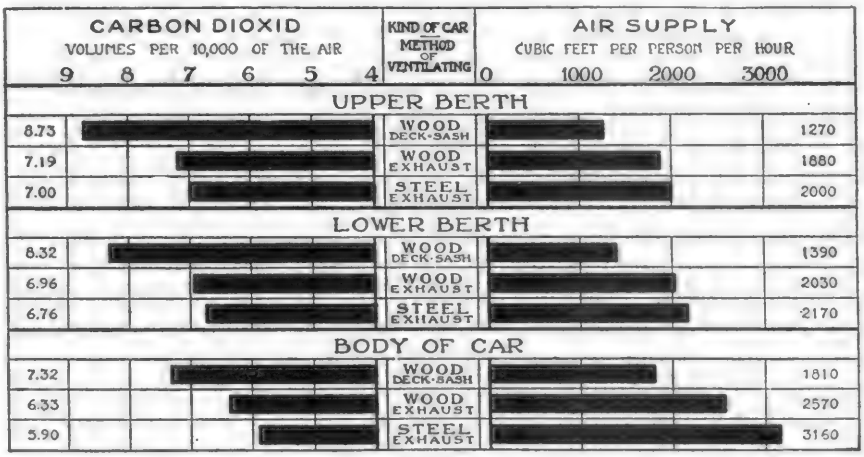
1. Natural ventilation (Deck-Sash Method)
   Body of car: $CO_2 = 7.32$; air supply to car = 29,700 cu. ft. per hour.
   Lower berth: $CO_2 = 8.32$; air supply per berth = 1,390 cu. ft. per hour.
   Upper berth: $CO_2 = 8.73$; air supply per berth = 1,270 cu. ft. per hour.
2. Exhaust ventilation (The Exhaust Method)
   Body of car: $CO_2 = 6.33$; air supply to car = 40,600 cu ft. per hour.
   Lower berth: $CO_2 = 6.96$; air supply per berth = 2,030 cu. ft. per hour.
   Upper berth: $CO_2 = 7.19$; air supply per berth = 1,880 cu. ft. per hour.

B. Steel Cars (Constructed without Deck-Sashes)

Exhaust ventilation.
   Body of car: $CO_2 = 5.90$; air supply to car = 53,000 cu. ft. per hour.
   Lower berth: $CO_2 = 6.76$; air supply per berth = 2,170 cu. ft. per hour.
   Upper berth: $CO_2 = 7.00$; air supply per berth = 2,000 cu. ft. per hour.

The comparisons made in the preceding summary will be made clearer by consulting the accompanying chart, in which the CO_2 and the equivalent hourly air supplies per person are grouped for the three classes of cars, showing their relations as established by a study of the air of the aisle, the lower berth, and the upper berth, respectively.

The preceding determinations of CO_2 and computations of air supply refer to the running car. When a train stops the active ventilation is much reduced and the CO_2 rises. It may finally reach a maximum of 20 volumes in 10,000, though it usually stops around 15. This rise in the CO_2 is generally detected within a very short time—one or two minutes. On starting again the air supply is increased and the CO_2 falls rapidly. In working out the series of observations presented in this and previous studies no attention was paid to stops lasting up to four or five minutes. Samples taken after those of longer duration were dropped out of consideration.



COMPARATIVE CO_2 AND AIR SUPPLY OF BERTHS AND AISLES IN STEEL CARS WITH EXHAUST VENTILATION, AND IN WOOD CARS WITH EXHAUST AND NATURAL VENTILATION.

Had attention been confined strictly to the running car the results would be changed slightly; the CO_2 would be a

little lower and the equivalent air supply proportionately higher.

It is probable that the power of exhaustion developed by these ventilators is very slight as measured by differences of the internal and external barometric pressure. They no doubt act mainly by furnishing a ready exit and continuous outflow of that air forced in by the wind, preventing its damming back near the places of entrance. In this way a constant upward movement of the incoming air is assured, and this leads to a constant and equalized renewal of the air in the lower levels.

Efficiency of Underground Steam Main Construction.

A chart showing the effect of increased efficiency of insulation on the value of a pipe main, together with the formula from which it was plotted, was presented by Byron T. Gifford at the recent annual meeting of the Engineering Society of the American District Steam Company.

It is pointed out that the efficiency of underground steam distribution pipe line construction is not necessarily dependent upon its durability. A construction may be durable, but not efficient. The efficiency of a pipe covering is defined as the percentage of heat saved by using the covering. For example, 90 per cent. efficiency means that the covering saves 90 per cent. of the heat lost by a bare pipe.

In the case of central station heating systems the efficiency is considered to be the percentage of heat transmitted as compared to the total amount of heat delivered to the pipe line. This can be expressed by the formula: $\frac{h}{H}$

Where h = total heat transmitted by the line.

H = total heat delivered to the line.

Also h = H — L, where L = the line loss.

In central station steam heating the pipe line loss is comparatively constant, for the reason that the temperature of the insulating medium and the temperature of the heating medium are approximately constant all the time.

It is seen, therefore, that the percentage of efficiency varies with the steam consumption and in inverse proportion. For example, if the heating system is receiving its full capacity (we will assume 100,000 lbs. steam per hour) and the line is losing 2,500 lbs. steam per hour, the percentage of loss is 2.5 per cent., or a percentage of efficiency of 97.5 per cent.

If, owing to weather conditions, the pipe line is delivering only 50 per cent., and consequently receiving only 50 per cent. of its capacity, the line loss remaining constant, the percentage of efficiency is only 95 per cent. At 25 per cent. of the capacity the percentage of the efficiency would be 90 per cent. This percentage expression, therefore, tells us really nothing unless we know the total steam delivered to the pipe line, and for that reason central heating engineers always express the line loss in pounds of steam per hour, instead of in terms of percentage.

The line loss in underground steam mains varies. Some of the most efficient construction loses 0.04 or less of a pound of steam per square foot of underground surface per hour. Other insulations lose from that amount up to 0.14 lbs. or more per square foot of surface.

In order to show the advantage of the more efficient coverings we will take a concrete case:

Number of square feet of surface in mains and services equals 13,423 sq. ft.

Number of pounds steam per hour capacity equals 30,000 lbs.

Average selling rate per 1,000 lbs. of steam, 55c.

Average length of heating season, 5,832 hrs., October 1 to June 1.

		Pounds Steam per Season.
No. 1 line loss at	0.04 =	3,131,316
No. 2 " "	0.05 =	3,914,147
No. 3 " "	0.06 =	4,696,874
No. 4 " "	0.07 =	5,479,806
No. 5 " "	0.08 =	6,262,632
No. 6 " "	0.09 =	7,045,463
No. 7 " "	0.10 =	7,828,294
No. 8 " "	0.11 =	8,611,021
No. 9 " "	0.12 =	9,393,748
No. 10 " "	0.13 =	10,176,680
No. 11 " "	0.14 =	10,959,612

13,423 x 0.04 x 5,832

Any heating plant, whether an independent or a "by-product" plant, will or should sell as much of the heat generated as possible, or, to express it differently, only sufficient heat should be generated to take care of the line loss and the sales. If any heat can be saved in the line transmission, due to increase in efficiency of insulation and construction, such saving should be used to measure the value of the increased cost of a highly efficient pipe line as against a method of construction and insulation costing a less investment to install.

Assuming the generating cost of steam as 30c. per 1,000 lbs., we find that the line

losses in the table above given will amount to the following:

Line loss	@ 0.04 (No. 1)...	$939.00
" "	@ 0.05 (No. 2)...	1,173.00
" "	@ 0.06 (No. 3)...	1,409.00
" "	@ 0.07 (No. 4)...	1,744.00
" "	@ 0.08 (No. 5)...	1,879.00
" "	@ 0.09 (No. 6)...	2,113.00
" "	@ 0.10 (No. 7)...	2,348.00
" "	@ 0.11 (No. 8)...	2,583.00
" "	@ 0.12 (No. 9)...	2,848.00
" "	@ 0.13 (No. 10)...	3,053.00
" "	@ 0.14 (No. 11)...	3,288.00

From this we can calculate the amount of money one insulation is worth more than another. For example, compare No. 1 and No. 8.

	Per Year.
The line loss with No. 8...	$2,583.00
The line loss with No. 1...	939.00
Saving in line loss.....	$1,644.00

We know that a well-constructed pipe line will last at least 20 years. We also know that 5 per cent. is a fair rate for interest on money. With a twenty-year life we would charge for depreciation 3½ per cent. (sinking fund) of the investment. This shows us, then, a fixed charge of 8½ per cent. on our investment which must be paid every year. To calculate the amount we could afford to spend for the more efficient covering we should compare the fixed charges (interest and depreciation) on the additional investment with the decreased income due to greater line loss.

From the above we see No. 1 as against No. 8 insulation will save $1,644 per year. This amount of money is 8½ per cent. on $19,341.20. Therefore, if we paid $19,341 more for the above-mentioned 13,423 sq. ft. of underground pipe surface, we would be justified in doing it, which means that on size of the pipe line, No. 1 insulation is worth $19,341 more than No. 8 insulation.

Under these conditions the amount of

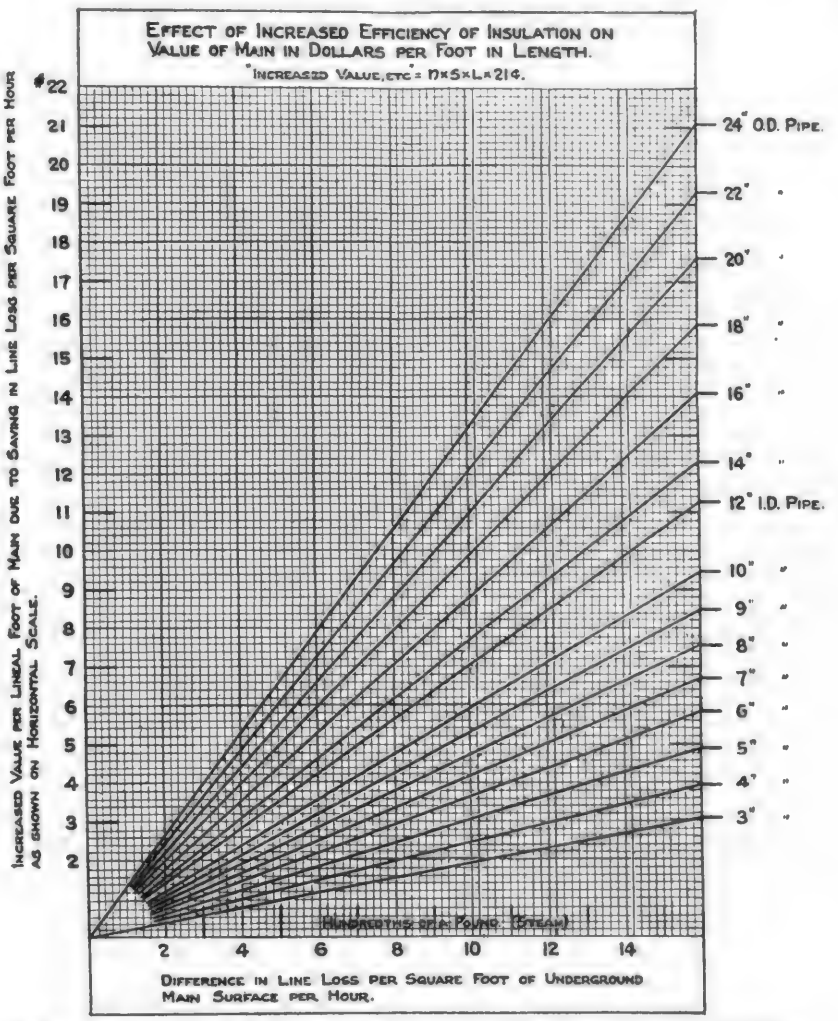


CHART SHOWING RELATIVE EFFICIENCY OF PIPE INSULATION.

saving per square foot of surface is as follows:

$$\frac{\$19,341}{13,423} = \$1.44 \text{ per sq. ft.}$$

The line loss on No. 1 is 0.14 lb. steam per sq. ft. per hour.

The line loss on No. 8 is 0.11 lb. steam per sq. ft. per hour.

Difference in line loss 0.07 lb. steam per sq. ft. per hour.

Therefore for each 1-100th of a pound of steam we can save per square foot of surface per hour, we can afford to spend

$$\frac{\$1.44}{7} \text{ equals 20.6c. per square foot to save it.}$$

With this figure in mind, say 21c., it is not difficult to properly classify and value different styles of insulation.

For example:

1,000 ft. of 8-in. line.

To compare two insulations, one with a line loss of 0.05 lb. per hour and one with a line loss of 0.14 lb. per hour, the difference equals 0.09 lb.

Formula: n x s x L x 21c.

Where n equals the number of hundredth of pounds steam loss per sq. ft.,

s equals surface of pipe per lineal foot.

L equals length of line.

21c. equals constant based on 30c. per 1,000 lbs. of steam, 5,900 hours per season.

Substituting the values in the formula we have 9 x 2.25 x 1,000 x 21 equals $4,252.50.

This shows us that $4.25 per lineal foot of 8-in. line is the increased value of the more efficient insulation as compared to the less efficient.

Another example:

800 ft. — 12-in. line
1,200 ft. — 10-in. line
3,600 ft. — 8-in. line
4,200 ft. — 6-in. line
7,300 ft. — 4-in. line (Service)

The number of square feet of surface in the above lines equals 29,952 sq. ft.

Compare 0.04 and 0.09 insulation as shown in table as No. 1 and No. 6. Difference equals 0.05 lb. steam per hour per square foot.

From the formula and substituting

5 x s x L x 21c.

s x L = 29,952.

5 x 29,952 x 21c. = $31,449.60

which is the amount of money that No. 1 exceeds No. 6 in value, or which 0.04 insulation exceeds 0.09 insulation.

The accompanying curve shows the value of efficient insulation, based upon the formula here given.

HOW TO USE THE CHART.

As an example in the use of the curve, take a 12-in. pipe line, where the difference in efficiency is 0.08 lb. steam per hour. Find 8 on the horizontal scale and follow this line up to the 12-in. line, then follow horizontally to the left and we find we reach a difference in value of $5.61 per lineal foot of 12-in. line.

Ohio Public Service Commission Promulgates New Rates, Rules and Regulations for Central Station Hot Water Heating

Important Decision Handed Down in the Case of the Toledo Railways & Light Company, Toledo, O.

A decision that will have an important bearing on the central station heating industry in Ohio has been given by the Public Service Commission of Ohio in connection with a complaint that the Toledo Railways & Light Company, of Toledo, O., had advanced its rates foi hot water heating service without notice. The matter has been before the Ohio commission for nearly a year and the decision prescribes rules for determining the amount of radiation required, rates for service and the specifications to be met in such service.

The commission states at the outset that the "schedule of rates, joint rates, tolls, rentals, classifications and charges for hot water heating, and rules and regulations affecting same" is "incomplete, indefinite, obscure, difficult of comprehension and subject to discrimination in application." The company, therefore, is ordered to cancel its present schedule and to publish a new schedule of rates, rules and regulations for hot water heating, before May 31, 1913, which must include the following provisions:

Rule for Determining Square Feet of Radiation Required to Heat Building.

Take area of exposed walls in building. From this subtract the area of window and door openings (frame measurement) in exposed walls. This remainder should be divided by wall constant (see table) and to the result should be added the area of window and door openings (frame meas-

urements). This sum should be multiplied by 75, and to this result should be added the cubic contents of the room. This sum should be multiplied by temperature constant (see table). The result is the square feet of radiation (cast iron) required to heat building when building is of good construction.

WALL CONSTANTS.

1 for ⅞-in. wall.
2 for 2-in. wall.
3 for 4-in. wall.
5 for 6-in to 9-in. wall.
7 for 9-in to 10-in. wall.
8 for 13-in. to 27-in. wall.

TEMPERATURE CONSTANTS.

0.0075 for 65° F.
0.0082 for 70° F.
0.009 for 75° F.

Any room or space having an opening which may communicate with the rooms or space to be heated, must be included in the measurement for space heated, whether radiation be installed or not in such room or space.

The rule here given is for "ideal conditions," requiring the minimum amount of heat for given cubic contents. To the radiation requirements thus calculated, there must be added a percentage to provide for exposed locations, bad construction, insufficient or improper repairs and other conditions which would make the minimum radiation requirement inadequate to keep the building comfortably warmed. For these conditions, which cannot be ascertained by general rule, add from 5% to 25% above the minimum for ideal conditions.

In all cases where the conditions are not ideal, the occupant shall have the opportunity of making the necessary repairs and changes.

It is specified that the heating company must furnish hot water in sufficient quantity to heat the building to a temperature of 70° F. in the coldest weather, provided that sufficient radiation be installed by the consumer to maintain the desired temperature. Evidence of the sufficiency of quantity of water shall be that the temperature of the hot water has not dropped more than 30° F., while passing through the consumer's heating system, as shown by not less than four tests taken 15 min. apart, in succession, tests to be made at the point of entrance of service to the building.

The surface area of all hot water pipes installed in the basement or elsewhere, not included in the measurement for radiation, will be charged for as radiation unless covered with at least 1-in. covering.

Consumers connected to the hot water service September 30 or later will be charged for 50% of the expired portion of the heating season and at the full rate for the balance of the season which is specified as running from September 15 to May 31.

RATES FOR DIRECT RADIATION.

The following rates are ordered to be put into effect:

Amount of radiation installed, sq. ft.	Cost of radiation per season, per sq. ft.
0 to 500	$0.20
500 to 2,000	0.1888
2,000 to 5,000	0.1777
5,000 or over	0.1666

40% of the above rates added for indirect radiation.

A discount of 10% allowed if paid within ten days from date of bill.

In regard to the piping and connections, the decision provides that "all pipes and connections which are now or may be hereafter placed outside of the basement wall of said premises, at the expense of the company, shall be and remain the property of the company and subject to its exclusive control."

According to the commission's ruling, the new schedule of rates, etc., will become effective September 15, 1913.

National District Heating Association.

The fifth annual convention of the National District Heating Association will be held in Indianapolis, Ind., Tuesday, Wednesday and Thursday, May 27, 28 and 29, 1913. The headquarters of the convention will be the Claypool Hotel, and the sessions will be held in the hotel's assembly room.

There will be an exhibit in connection with the convention in the same room, in which the professional sessions are held.

Reservations for hotel accommodations should be made directly with the hotel, and should be secured in advance because of the great automobile races on May 30, when the hotels will be crowded.

Reservations for space in the exhibit should be made directly with the Secretary, Mr. D. L. Gaskill, of Greenville, O. A considerable number have already been engaged for the occasion.

Following is the program as outlined for the entire meeting:

FIRST SESSION, TUESDAY, MAY 27, 10.00 A. M.

Welcome Address, by C. A. Bookwalter, Indianapolis, Ind.

Response, by O. C. Irwin, of the Public Service Company, Berlin, Wis.

Roll Call.
Reading of Minutes.
Reading of Applications for Membership.
Election of Members.
President's Address.
Report of Executive Committee.
Report of Secretary-Treasurer.
Appointment of Nominating Committee.
Appointment of Convention Committees.
Report of Committee on Meter, S. Morgan Bushnell, of Illinois Maintenance Co., Chicago, Ill., Chairman.
Report of Committee on Rates, J. L. Hecht, of Public Service Company of Northern Illinois, Chicago, Ill., Chairman.
Report of Committee on Station Records, H. R. Wetherell, of Peoria Gas & Electric Co., Peoria, Ill., Chairman.
Discussion.

SECOND SESSION, TUESDAY, MAY 27, 2.00 P. M.

Paper—"Hot Water Heating for Residence Districts," by A. C. Rogers, Toledo Railways & Light Co., Toledo, O.
Paper—"Possibilities of Hot Water Heating," by N. M. Argabrite, of Indiana General Service Co., Elwood, Ind.
Report of Nominating Committee.

THIRD SESSION, WEDNESDAY, MAY 28, 9.30 A. M.

Paper—"District Heating on the Pacific Coast," by Chas. F. Murphy, of United Light & Power Co., San Francisco, Cal.
Discussion on "The Use of Bleeder Turbines," by the users.
Election of Officers.

FOURTH SESSION, WEDNESDAY, MAY 28, 2.00 P. M.

Paper—"Commission Control of Utilities," by D. L. Gaskill, secretary of the Ohio Electric Light Association.
Paper—"Appraisal of Heating Properties," by Harold Almert, of H. M. Byllesby Co., Chicago, Ill.
Paper—"Station Designs with Special Reference to Overload Capacities," by Mr. Denman, of Edison Illuminating Co., Detroit, Mich.

FIFTH SESSION, THURSDAY, MAY 29, 9.30 A. M.

Paper—"Is District Heating Profitable to the Central Station?" by C. J. Davidson, of Woodmansee & Davidson, Chicago, Ill.
Paper—"Operating Economies in Heating Large Factory Buildings," by Edward L. Wilder, Assistant Industrial Engineer of Rochester Railway & Light Co., Rochester, N. Y.

ENTERTAINMENT.

May 27 (Evening), "Get Together party for all attending, at the Hume-Mansur Roof Garden.
May 28 (Afternoon), Theatre party for the ladies.
May 28 (Evening), for all attending, party —Hume-Mansur Roof Garden, vaudeville entertainment and buffet lunch.
May 29 (Afternoon), Automombile ride for ladies.
May 30, Automobile races.

ENTERTAINMENT COMMITTEE.

Edward McKee, president, Merchants Heat and Light Co.
E. Darrow (chairman), general manager, Merchants Heat and Light Co.
B. D. Christian, contract department, Merchants Heat and Light Co.
C. C. Perry, president, Indianapolis Light and Heat Co.
Thomas Wynne, secretary, Indianapolis Light and Heat Co.
J. Harris, general manager, Peoples Light and Heat Co.
John Patrick, secretary, Indianapolis branch, Armstrong Cork Co.
F. Nealis, Indianapolis branch, Westinghouse Electric & Mfg. Co.
Richard Ferrel, Indianapolis branch, General Electric Co.
L. S. Shaw, Indianapolis branch, Westinghouse Machine Co.
C. Weir, Indianapolis branch, H. W. Johns-Manville Co.
Chas. Shotwell, Indianapolis branch, Fairbanks, Morse Co.
Thos. Endicott, Indianapolis branch, Crocker-Wheeler Co.
Gordon Verney, president, Danville Electric Co.
John Kester, general manager, Noblesville Light and Heat Co.
R. C. Steuve, Indianapolis branch, Allis-Chalmers Co.
C. E. Lewis, Commercial Club, Indianapolis, Ind.
J. Edward Krause, president, Indiana Hotel Keepers' Association.
Frank Lawrence, president, Claypool Hotel, Indianapolis.
J. Kamps, Indianapolis branch, Platt Iron Works Co.

A bill providing compensation for employees of the United States suffering injuries or occupational diseases in the course of their employment has been introduced in the Senate by Senator Kern of Indiana. This bill has been drawn after careful investigation by the American Association for Labor Legislation and is designed to supplant the present law. A feature of the bill is a provision for compensation for occupational diseases such as lead poisoning. The Kern bill also includes all civilian employees of the Government, numbering 350,000, instead of one-third under the present law.

Dallas, Texas, will have one of the most expensive and what is claimed to be the heaviest steel constructed building south of St. Louis, when the new Busch Building, now under construction, is finished. The building occupies a site 100x125 ft. and will be 16 stories in height, with attic, tower, and basement. The cost is about $1,000,000. The heating, lighting and power will be furnished from the Adolphus Hotel by means of a tunnel through solid rock for a distance of 210 ft. This tunnel is 6 ft. x 6 ft., located 21 ft. below the street level.

THE HEATING AND VENTILATING MAGAZINE

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A. S. ARMAGNAC..... ..... *President*
GUSTAVE PETERSEN.... *Secretary and Treasurer*

A. S. ARMAGNAC, Editor
GUSTAVE PETERSEN, Business Manager

European Representative:
W. G. HOLLINWORTH, 304 High Holborn, London, W. C.

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THE first important ruling of any public utility commission relative to central heating plants and their operation has recently been made by the Ohio Public Service Commission in the case of the Toledo Railways & Light Company. This company operates a central hot water heating system and has heretofore sold its heat at flat rates. In view of this and other features, which made the subject a complicated one to deal with, the fairness of the decision must be very gratifying to central heating engineers and managers.

There is nothing that has been more difficult for the layman to understand than the amount of radiation required for his building, or, as it is often called, "the required radiation." There is nothing more important to the central hot water heating plant than to have a sufficient amount of radiation set in each building heated. The decision contains a formula for figuring the required radiation which is easily understood and requires all rooms to be heated or paid for as heated, for they will be heated anyway. While the formula is simple, it is sufficiently exact to serve as a guide and the rules concerning its application are flexible enough to allow the heating company to adapt itself to any unusual conditions.

The requirement that the heating company must furnish a sufficient quantity of hot water is entirely equitable and can and should be fulfilled by any hot water heating company. The same may be said of the ruling that exposed piping, in which all uncovered pipes are considered as radiating surface, is to be charged for at full rates. The clause relating to payment of the service for part of the season, while not complete, may be met by the heating company through its rules and regulations. It will be noted that this section does not stipulate what percentage each month, or portion of each month, is of the entire heating season. For example, a consumer connecting to the system October 15, as compared with a consumer connecting November 15, does not affect the heating company's operation and income as much, and a proper arrangement should be made to take care of this difference.

The subject of rates is not discussed or commented upon in the decision, but the new schedule ordered is practically the one the company had in force prior to the decision.

On the whole, the decision may be said to be clear, able and noteworthy. It will establish a good precedent which must of necessity be followed in other heating cases. It is a great help in the progress of central heating and, at the same time, a distinct step in advancing public utility control by State commissions.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Notes from a Data Book on Factory Heating

Standard and other practice in the heating of factories from the standpoint of the man on the job were presented at the April meeting of the New York Chapter of the heating engineers' society by Wallace F. Goodnow. Mr. Goodnow, who is connected with the Vento department of the American Radiator Company, illustrated his remarks with a number of lantern slides showing typical hot blast installations; his address being principally devoted to fan systems.

He said that, generally speaking, ventilation in factories is almost entirely disregarded, since factory owners, as a rule, do not consider the additional expense of first and operating costs of a ventilating system as a dividend payer. The speaker maintained, however, that the additional cost of installing and operating a ventilating system brings a larger financial return upon the money invested than any other portion of the equipment. A 10% to 20% loss of efficiency of the workers on comparatively few days will, in most industries, show considerably greater loss than the fixed and operating charges of a ventilating plant.

The speaker mentioned several points in considering the heating requirements that are often overlooked by the owner and contractor, such as the height of the ceiling, type of building, time required to heat (where it is the custom not to heat continuously) and the air leakage. Another point to be considered is the process used in the building, whether it absorbs or gives off heat, also whether the doors are large and are open much of the time.

Where the ceilings are high, doors large and open a great deal of the time, and when the buildings have large areas and are heated only when occupied, or if specified air conditions are to be maintained, the speaker was emphatic in favoring the use of the blower system.

As an illustration of his point, Mr. Goodnow cited a simple shed-like building, with a slightly pitched roof, having a total cubic contents of 128,000 cu. ft., a glass surface of 3,200 sq. ft., net wall surface of 4,080 sq. ft. and 8,500 sq. ft. of roof. This would give a net heat loss of 414,408 B. T. U. per hour. To this he added 120,000 B. T. U. for air leakage, 33,152 B. T. U. for extra height, the building being 16 ft. average height, and 189,000 B. T. U. where the heat was not kept on during the night, making a total of 756,000 B. T. U.

This would mean 2,000 sq. ft. of heating surface in the form of wall radiators. If the building were kept heated, 1,500 sq. ft. would be sufficient. He suggested, as another way, to make the smaller surface serve, to increase the steam pressure during the warming time.

The speaker accounted for the comparatively large amount of heating surface by saying that he was considering a case where a specified temperature was required. The heating of a building of this character, he said, if direct radiation were used, would cost about $660.00, without the boilers, or, if heated nights, about $520.00.

COMPARISON WITH A FAN SYSTEM.

With a fan system, the speaker said that the total heat losses would be the same in all respects except that of the height which could be disregarded. For morning heating, care would have to be taken to install an engine large enough to run the fan at about 25% above the normal speed. There would thus be a total heat loss of 534,358 B. T. U. per hour, and assuming that each cubic foot of heated air gave off 1 B. T. U. in cooling 60° F., the building would require 8,900 cu. ft. of air heated to approximately 120° F., allowing for line drop and other items.

The speaker estimated the cost of such a plant, including fan, engine, ducts, etc., to be about the same as that of a direct heating system, to do the same work, which was $660.00. The speaker said that the owner would, however, probably take the $530.00 direct radiation plant, as he could save $120.00 on the first cost.

The operating costs of the two systems were considered by the speaker to be about the same, so that the only advantage a fan system would have in a building of this type is its adaptability to meet changing

conditions and the possibility of ventilating during the warm period.

Mr. Goodnow then proceeded to give the figures where the building was to be used as a planing mill, with a shaving exhaust system handling a large amount of air. In such a case, he said, all that would be necessary with a fan system would be to add a few rows to the heater and supply the additional air from outdoors. With the direct radiation system, he said it might be quite difficult to get the additional surface in the building. The same condition might hold if at any time processes or other conditions should arise which might require ventilation.

From this simple type of building, the addition of 1 ft. to the height would change the amount of surface 2% in a direct radiation plant and about ½% in a fan system, until, at an average height of 20 ft., the difference in operating and first cost commences to show strongly in favor of the fan system.

NOVEL RULE FOR FIGURING FAN BLAST SYSTEM.

Mr. Goodnow gave a novel rule for figuring a fan system of factory heating, which he said had proved successful. This method disregards all conditions of exposure, except doors which are open a great deal and which have auxiliary heat openings near them. By this method, where the factories are of open construction and the heating requirements are from zero to 60° F., the rule is to bring the air to within 5 or 6 ft. of the floor and discharge it directly towards the floor at a velocity of from 500 to 900 ft. per minute, with the outlets from 20 to 30 ft. apart. If one row of outlets cannot be placed within 15 ft. of the side walls, the outlets should be installed blowing towards them at the junction of the floor line and wall with outlets not over 15 ft. up from the floor, and the air dis- The air leaving the outlets is to be figured charge being at from 800 to 90 ft. velocity. at 120° F., plus the drop in the line. Allow 1 cu. ft. of air for each square foot of floor space. Allow in heater jacket space for one extra section in depth. Additional allowance should be made for process work which absorbs or gives out heat, the heater being sized accordingly.

Mr. Goodnow also referred to the revival of the warm floor system of heating by means of concrete ducts running underneath the floor.

In the subsequent discussion of the subject Mr. Barwick showed how, in one case, an excessive window leakage completely upset the operation of a hot blast system in one end of a building.

Mr. Lyle spoke of the advantages of continuous heating, especially where high-speed machinery is used. He gave an interesting reason for the economy of using cold outside air in fan heating, rather than recirculating the inside air, by stating that when cold air is used, there is a slight plenum created in the building.

Mr. Ritter described a case of factory heating, where the air was carried in concrete ducts underneath the floors. With a temperature leaving the fan of 200° F. and a return temperature of 160° F., the building was comfortable, although the thermometer inside registered only 58° F. He attributed the feeling of comfort to the warm floors. The building in question was of saw-tooth roof construction, 500 ft. long and 200 ft. wide. The concrete air tunnels were carried down the sides of the building, one on each side, connected to a return tunnel running down the center.

Other features of the meeting included a report of the committee on tests, giving the results of a trip to inspect an interesting ventilating equipment at the Mt. Prospect School, in Paterson, N. J. In this installation the radiators were encased in a box-like enclosure, the air being taken directly through the window and made to pass through the box and over the radiator by means of a small electric fan. A water pan in the bottom of the box was designed to humidify the air. The committee called attention to the fact that the device does not lend itself to humidity regulation, while the quantity of air delivered amounted to only 21 cu. ft. per person, and the distribution was not uniform. There were no means provided for removing foul air or objectionable odors. Attention was also called to the danger in case of fire, with this arrangement, of excessive smoke in halls. It was the committee's opinion that the arrangement has no place in a modern up-to-date school equipment. The report was accepted and placed on file. In presenting the committee's report Chairman James A. Donnelly stated that assurances had been received from colleges of their willingness to co-operate in making tests, and of what they were now doing in this direction, some of which is of interest to heating engineers.

President F. G. McCann appointed the following as a nominating committee: Frank T. Chapman, F. K. Chew, C. R. Treat, Geo. A. Knight and C. A. Scott.

Attention was called by Mr. Lyle to the plans for the chapter dinner which will be held May 12 at the Engineers' Club. The principal speaker of the evening will be Dr. M. W. Franklin, whose address on

ozone at the recent annual meeting of the society has been so widely discussed.

W. M. Mackay and Hugh J. Barron were appointed a committee to attend the memorial services for Dr. John S. Billings, at the New York Public Library.

Illinois Chapter.

The heating equipment for a railroad terminal, comprising a 48-stall roundhouse, various repair shops, storehouses, etc., and in which the heating and power loads are practically balanced, was described by August Kehm, at the April meeting of the Illinois Chapter. Mr. Kehm explained that at the time of considering this problem, the owners had given careful consideration both to the fan system of ventilation and heating, and to direct heating, with natural ventilation, finally deciding on the latter.

The roundhouse is heated by direct steam in the form of wall coils placed in protected sides of the pits, 432 sq. ft. to each pit. Wall radiation is also placed on the outside walls to take care of this exposure. About 75 per cent. of the radiation, amounting to 28,000 sq. ft., is in the pit.

The question of heating the outlying shops required a great deal of thought, and a forced circulation of hot water was finally decided upon. The tunnels are about 1,500 ft. long. The method of taking care of the expansion, both in the tunnels and in the piping itself was fully illustrated and explained. The amount of expansion was also given and the study of this problem afforded a most instructive and pleasant evening.

In the absence of the president and vice-president, Past President E. F. Capron presided over the meeting, which was held in the banquet room of Vogelsang's Restaurant, Chicago.

Mr. Harte reported that the Chicago Ventilation Commission is still holding bimonthly meetings and is making progress in its work.

The committee to consider the question of compulsory ventilation laws in connection with the present legislature, owing to the absence of the chairman, was unable to accomplish very much other than to learn that the ex-Governor has appointed a commission to draw up a State building code, and that this commission has embodied compulsory ventilation features in its code to the extent of proposing 1,500 cu. ft. of air per person per hour for theatres, assembly halls, etc., and 1,200 cu. ft. per pupil for class rooms in schools. This committee has arranged to meet the State committee and will endeavor to have embodied in the State building code the compulsory ventilation bill drawn up by the chapter some time ago.

As a question of discussion, Mr. Kehm brought up the necessity of securing permanent downtown quarters for the chapter so that it could begin the collection of a library and reference files. Mr. Kehm was delegated a committee of one to look into the matter.

The secretary reported the election to membership on the last ballot of J. M. Frank. The meeting was then turned over to the committee, consisting of August Kehm and R. M. Stackhouse, who provided, as a starter, a cabaret performance. This was followed by Mr. Kehm's paper.

The subject for the chapter's May meeting is "The Commercial Position of the Heating and Ventilating Engineer."

Massachusetts Chapter.

A discussion of wall radiators, followed by a description of the air conditioning in the Boston Museum of Fine Arts, were features of the April meeting of the Massachusetts Chapter, held at the City Club, Boston, April 8. The chair was occupied by President Frank Irving Cooper.

In the discussion of wall radiators, the frequent breaks found in such apparatus came in for comment, interesting experiences in this connection being related by Messrs. Smallman, Morrison, and W. W. MacLean, superintendent of the Museum of Fine Arts, who was the principal guest of the evening.

The point was brought out that certain designs of the wall type of cast-iron radiators have been known to break, after installation, caused by the strain not being properly taken care of or equalized in the design. The method of installing and hanging was also taken up and many specific cases were explained, but it was the opinion of the engineers that this trouble was chiefly caused by faulty design of the radiator. It was decided that it was of sufficient importance to refer this matter to some of the large radiator manufacturers. A general discussion of the air-conditioning at the Museum of Fine Arts followed, Mr. MacLean explaining at length the installation, the effect and general benefits.

At the next meeting, humidity will be the subject and invitations to attend the meeting will be sent to several physiologists who will be expected to participate in the discussion.

The chapter was represented at the meeting of the Student Branch of the American Society of Mechanical Engineers at Sheffield Scientific School, New Haven, April 16.

Radiator and Fireplace on Porch.

The accompanying illustration shows an unusual arrangement for a residence porch which was adopted in the home of Mr. William W. Hearne, Beaver, Pa. This residence was designed by D. Knickerbacker Boyd, of Philadelphia.

D. Knickerbacker Boyd, Architect.
RESIDENCE OF W. W. HEARNE, WAYNE, PA.

Current Heating and Ventilating Literature.

Under this heading is published each month an index of the important articles on the subject of heating and ventilation that have appeared in the columns of our contemporaries. Copies of any of the journals containing the articles mentioned may be obtained from THE HEATING AND VENTILATING MAGAZINE *on receipt of the stated price.*

HOT WATER HEATING—

Drop-Feed Hot-Water Heating System. Illustrates and describes features of an installation in a building covering a large area. 1500 w. Met. Work—Feb. 7, 1913. 20c.

Heating and Ventilating in Toledo Post-Office. Plans and description of the hot-water heating installation. 1500 w. Dom. Engng.—Feb. 15, 1913. 20c.

The Design of Hot-Water Supply Systems to Minimize Corrosion. F. N. Speller. Gives results of an investigation of present practice and the influence of the arrangement of the piping on corrosion. 1200 w. Eng. News—Feb. 13, 1913. 20c.

SHOP SYSTEMS—

Heat and Ventilation in a Large Foundry. Illustrates and describes a fan system with air recirculating arrangements. 1200 w. Ir. Age—Feb. 13, 1913. 40c.

RADIATOR AND FIREPLACE ON PORCH, RESIDENCE OF W. W. HEARNE, WAYNE, PA.

Legal Decisions

Evidence of Negligence.

Action was brought against the contractor furnishing the steam heating apparatus for a mill that was being constructed by one of its employes who was injured while assisting in hanging a line of steam pipe to the ceiling of the first story. The plaintiff had been sent to lower one of the hangers upon which the pipe rested. While doing so he stood upon a wooden horse, about 4 ft. high and 5½ ft. long. According to his testimony, when getting down, his shoe caught in a nail on the end of the horse and he was thrown forward to the floor. No evidence was offered to explain why or by whom the nail was driven there. The exposed part of the nail had been bent so that it projected about ¼ in. above the top of the horse and protruded about ⅜ in. beyond the edge. It was held that the defendant was not negligent in allowing the plaintiff to use the horse, notwithstanding the presence of the nail and the absence of warning to him. It was not the defendant's property, but was found on the premises when its work began, and was used by the carpenters and other workmen. There was no basis for an inference that one of the defendant's employes must have driven the nail, and nothing to show that the defendant should have inspected the horse in anticipation that others using it would be likely to drive nails into it.—Blake vs. John F. Johnston Co., Massachusetts Supreme Court.

Original Contractor As a Materialman.

A claim for a lien for labor and materials by a contractor for the installation of two solar heaters, etc., was attacked because it was said to be based on an original contract for more than $1,000, and was not reduced to writing, or filed for record, as required by section 1183 of the California Code of Civil Procedure, the contract price being $1,078. It was held that the contract was not an original contract within the meaning of the section, but a contract for the sale of materials to be used in the construction of the building. The test of the character of the contract is the relative value of the material and the labor supplied. If the value of the labor is small in comparison with that of the material, the claimant is a materialman. In this case the value of the fixtures and other material supplied was $950, while the labor cost was only $128. The claim was allowed.—Pugh vs. Moxley, California Supreme Court, 128 Pac. 1037.

No Implied Warranties in Contract Containing Express Warranties.

Action was brought for the price of a heating plant sold under express warranties. The defendant in a counterclaim alleged that the heating plant was of no value. The trial court directed a verdict for the plaintiff. This was reversed on appeal and a new trial ordered, the court holding that there was some evidence to support the defendant's allegation and that the case should have been submitted to the jury, although the defendant had not pleaded or proved a rescission of the contract. The defendant, without having rescinded, was entitled to have the jury pass upon his right to recover the part of the price he had paid, regardless of whether he had any right to recover on the other elements of damages claimed. The contract containing express warranties, there could be no implied warranties.—Sheafe vs. Zastrow, South Dakota Supreme Court.

Factory Heating and Lighting.

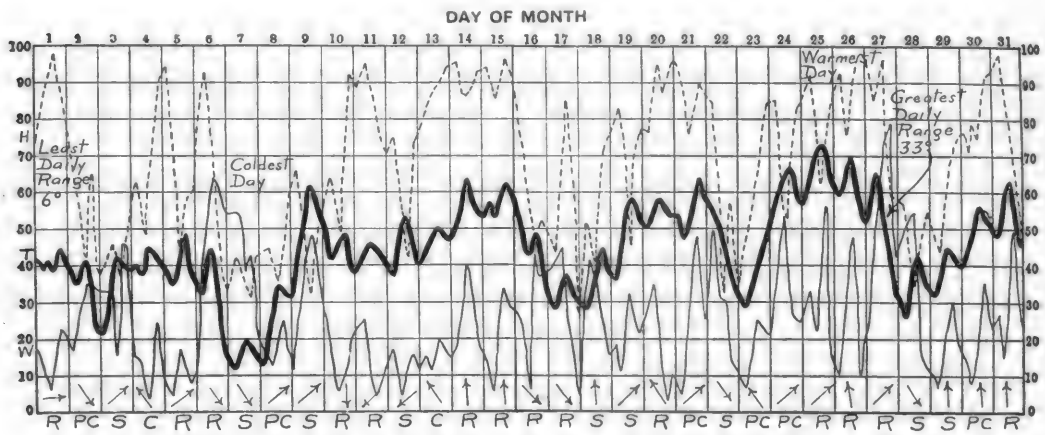
A number of heating engineers from New York and Boston participated in the discussion of factory heating and lighting at a meeting held by the Yale University Student Branch of the American Society of Mechanical Engineers at New Haven, Conn., April 16. Those present from New York included James A. Donnelly, William J. Baldwin, Robert W. Pryor, Jr., C. F. Chase, W. F. Goodnow, Frank K. Chew and George G. Schmidt. The Boston representatives were William G. Snow and R. E. Shaw. Others present were R. D. Reed of Westfield, Mass., and R. H. Mather, of Hartford, Conn.

William G. Snow gave a talk, illustrated with lantern slides, on the subject of air conditioning for factory buildings. R. W. Pryor, Jr., James A. Donnelly, W. F. Goodnow and Wm. J. Baldwin also participated in the discussion.

Guy Lowell, 225 Fifth avenue, New York, is to be the architect and superintendent of construction of New York's new court house. The plans which were selected from those of twenty-two competitors, provide for an unusual type of building, circular in form and resembling, in a general way, the style of architecture of the Coliseum in Rome.

The Weather for March, 1913

	New York	Boston	Pittsburgh	Chicago	St. Louis
Highest temperature, degrees F.....	73	73	75	65	74
Date of highest temperature.....	25	25	25	24	30
Lowest temperature, degrees F.....	12	10	6	—4	5
Date of lowest temperature.....	7	8	7	2	2
Greatest daily range, degrees F.....	33	35	38	33	34
Date of greatest daily range.....	27	9	21	24	23
Least daily range, degrees F.....	6	5	7	4	8
Date of least daily range.....	1	11	6	26	27
Mean temp. for month, degrees F.....	44	42	43	35.2	42
Normal mean temp. for month, deg. F..	37.5	35	39.5	34.4	43.5
Total rainfall, inches.....	5.17	4.81	4.37	3.44	7.97
Total snowfall, inches.....	0.1	0.5	2.0	7.0	8.6
Normal precipitation, this month, in....	4.1	4.08	3.01	2.55	3.43
Total wind movement, miles.....	16,433	9,536	11,509	13,172	10,416
Average hourly wind velocity, miles....	22.1	12.8	15.5	17.7	14
Prevailing direction of wind.....	S.W.	S.W.	S.W.	S.	S.E.
Number of clear days.....	7	10	5	4	11
Number of partly cloudy days.....	8	6	12	12	9
Number of cloudy days.....	16	15	14	15	11
Number of days on which rain fell....	15	13	17	15	11
Number of days on which snow fell...	1	1	6	9	5
Snow on ground at end of month, in...	None	None	None	None	None


DAY OF MONTH
Warmest Day
Greatest Daily Range 33°
Least Daily Range 6°
Coldest Day
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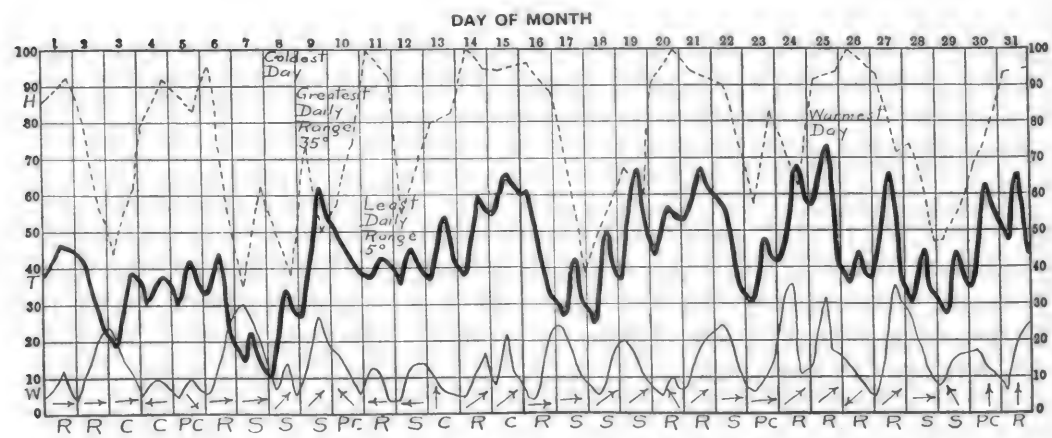
RECORD OF THE WEATHER IN NEW YORK FOR MARCH, 1913.
(Hourly Observations of the Relative Humidity are Recorded on This Chart.)


DAY OF MONTH
Coldest Day
Greatest Daily Range 35°
Least Daily Range 5°
Warmest Day
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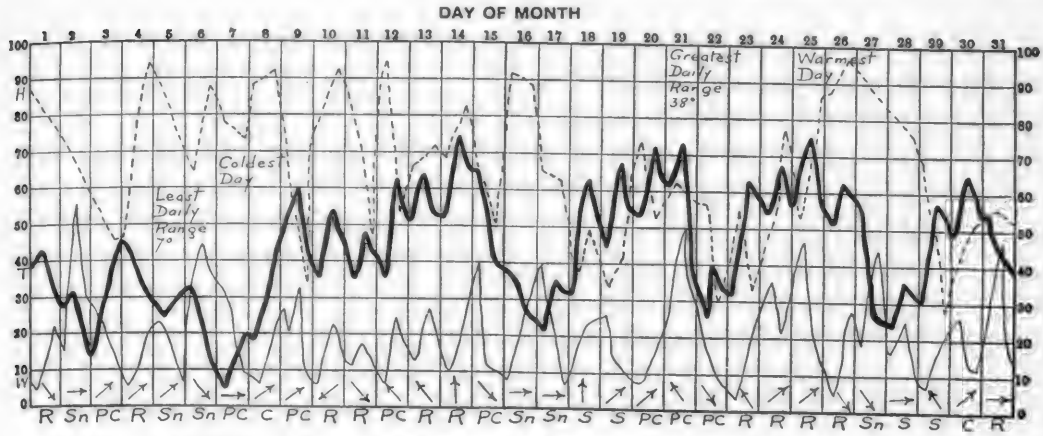
RECORD OF THE WEATHER IN BOSTON FOR MARCH, 1913.


DAY OF MONTH
Greatest Daily Range 38°
Warmest Day
Coldest Day
Least Daily Range 7°
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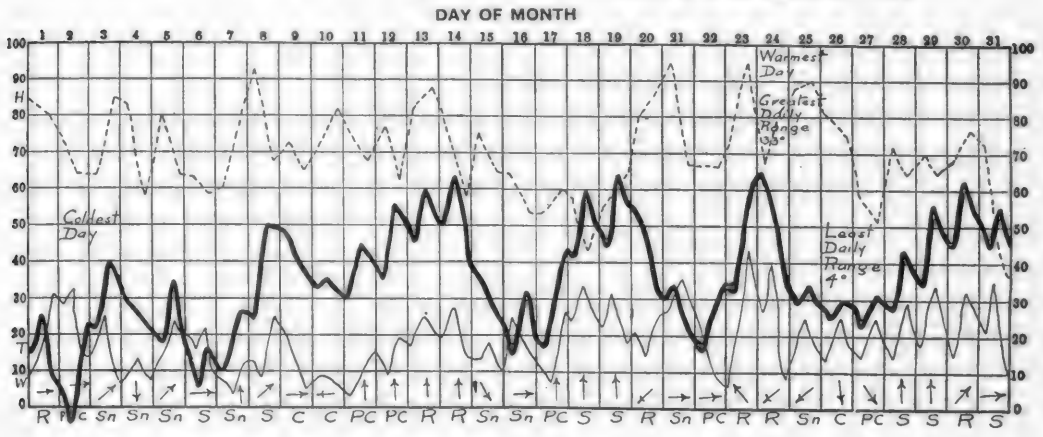
RECORD OF THE WEATHER IN PITTSBURG FOR MARCH, 1913.


DAY OF MONTH
Warmest Day
Greatest Daily Range 35°
Coldest Day
Least Daily Range 4°
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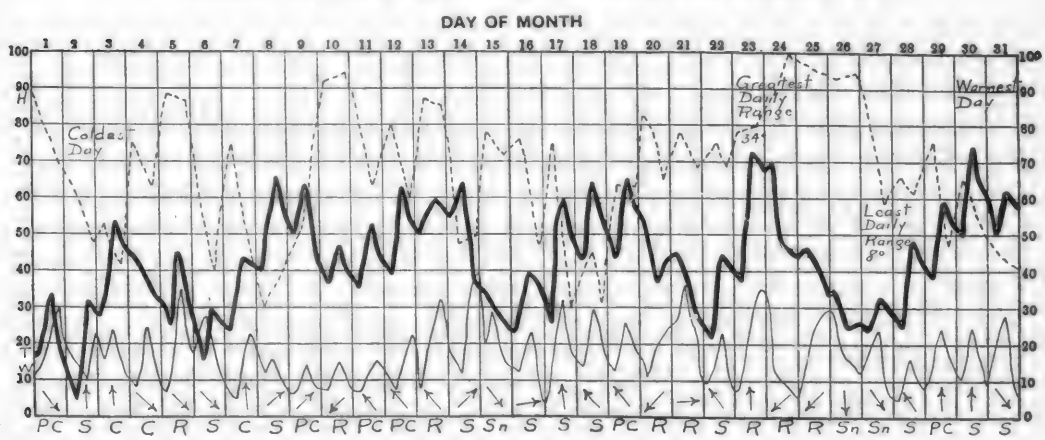
RECORD OF THE WEATHER IN CHICAGO FOR MARCH, 1913.


DAY OF MONTH
Greatest Daily Range 34°
Warmest Day
Coldest Day
Least Daily Range 8°
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RECORD OF THE WEATHER IN ST. LOUIS FOR MARCH, 1913.

Plotted from records especially compiled for THE HEATING AND VENTILATING MAGAZINE, by the United States Weather Bureau.

Heavy lines indicate temperature in degrees F.

Light lines indicate wind in miles per hour.

Broken lines indicate relative humidity in percentage from readings taken at 8 A. M. and 8 P. M.

S—clear, P C—partly cloudy, C—cloudy, R—rain, Sn—snow.

Arrows fly with prevailing direction of wind.

For Separate Contracts in Pennsylvania.

Through the activities of the Pennsylvania Association of Master Steam and Hot Water Fitters a bill was introduced in the Pennsylvania legislature, and has been passed by both houses, designed to separate heating, ventilating, plumbing and electric work from the general contracts on the construction of public buildings in Pennsylvania.

The bill was introduced by Mr. F. H. O'Neill on March 17 and was at once referred to the committee on public buildings. The fact that it was so soon reported to the House was taken to indicate that the bill had more than an even chance of being passed. Following is the text of the bill, which is listed as House Bill No. 1382:

AN ACT.

Regulating the letting of certain contracts for the erection, construction and alteration of public buildings.

Section 1. Be it enacted by the Senate and House of Representatives of the Commonwealth of Pennsylvania in General Assembly met and it is hereby enacted by the authority of the same That hereafter in the preparation of specifications for the erection, construction and alteration of any public building, when the entire cost of such work shall exceed $1,000 it shall be the duty of the architect, engineer or other person preparing such specifications to prepare separate specifications for the plumbing, heating, ventilating and electrical work and it shall be the duty of the person or persons authorized to enter into contracts for the erection, construction or alteration of such public buildings to receive separate bids upon each of the said branches of work and to award the contract for the same to the lowest responsible bidder for each of said branches.

Section 2. All acts or parts of acts inconsistent herewith are hereby repealed.

The Trade's Contributions to the Ohio Flood Sufferers.

The heating, ventilating and plumbing trades made prompt and liberal response to the calls for assistance from their fellow tradesmen who suffered in the recent Ohio floods. A relief fund was instituted by the Chicago Chamber of Commerce, which was divided into subdivisions for more effective work. Subdivision No. 44 comprised the heating, ventilating and plumbing trades, the committee in charge being composed of Harry Verbeek, manufacturers' representative, 1913 City Hall Square Building, Chicago, chairman; James Gardner, Gardner Metal Co.; George F. Hinds, Kellogg-Mackay Co.; Elmer E. Hunt, Ideal Ventilator Co.; Herman M. Hoelscher, L. Wolff Mfg. Co.; Kent Clow, Jas. B. Clow & Sons; C. C. Stringer, Republic Mfg. Co.; F. B. Howell, American Radiator Co.; Peter Munn, Chicago Association of Master Plumbers; and W. E. Marquam, editor *Domestic Engineering*.

Among those contributing to the flood relief fund are the following:

Crane Co., $5,000.00.
Vulcan Louisville Smelting Co., $50.00.
Alberger Pump & Condenser Co., $25.00.
Jenkins Bros., $25.00.
Powers Regulator Co., $25.00.
T Beggs & Sons, $10.00.
Illinois Malleable Iron Co., $500.00.
Gallagher & Speck, $25.00.
American Radiator Co., $1,000.00.
Republic Mfg. Co., $50.00.
M. J. Corboy Co., $25.00.
Narowetz Heating & Ventilating Co., ——.
Monash-Younker Co., $25.00.
C. H. Penny, Scott Valve Co., ——.
Mellish-Hayward Co., $25.00.
Findeisen & Kropf Mfg. Co., $50.00.
Weil Bros., $50.00.
Western Valve Co., $10.00.
Federal-Huber Co., $25.00.
Raymond Lead Co., $50.00.
L. Wolff Mfg. Co., $500.00.
J. J. Daly, Jas. B. Clow & Sons, ——.
D. E. Foskette, $10.00.
Employes of American Radiator Co., $182.25.
National Steam Specialty Co., $25.00.
C. T. Byrne, $25.00.
Jas. B. Clow & Sons employes, $160.00.
Henion & Hubbel, $25.00.
A. M. Maypole, ——.
Wm. J. Oliphant, ——.
C. H. Penny, $15.00.
Republic Mfg. Co. employes, $32.25.
Scott Valve Co., $25.00.
C. C. Todd, $10.00.
Harry Verbeck, $15.00.

Among the contributions from the heating and plumbing trade in Pittsburgh are the following: Pittsburgh Lamp, Brass & Glass Co., $25; Frick & Lindsey, $100; Monongahela Tube Co., $150; Iron City Sanitary Mfg. Co., $100; Wilson Snyder Mfg. Co., $25; Pittsburgh Malleable Iron Co., $100; Pittsburgh Piping & Equipment Co., $100; Reineke-Wagner Pump & Supply Co., $50; Standard Sanitary Mfg. Co., $500; Jarecki Mfg. Co., $100.

National Pipe and Supplies Association.

Trade conditions were treated from a broad point of view at the fourth annual meeting of the National Pipe and Supplies Association, held in Chicago, April 14-15. Among the speakers was Harry A. Wheeler, president of the Chamber of Commerce of the United States of America who discussed the present economic situation. C. V. Kellogg, of the Kellogg-Mackay Company, made the address of welcome to the members. Other speakers were J. J. Ryan who spoke on "The Business Outlook," W. E. Clow, Jr., of Jas. B. Clow & Sons, Chicago, and D. J. Mahoney, of the Savannah (Ga.) Supply Co. In the discussion of the trade outlook, an optimistic spirit was voiced by several of the speakers.

A resolution was passed urging the passage of laws that will effect banking and currency reform.

During the second day's session, addresses were delivered by Henry Aird, of the Aird-Don Co., Troy, N. Y., on "Some Essentials of a Successful Business," and by Alexander B. Pierce, of the Nelson Mfg. Co., St. Louis, Mo., on "Relations Between Manufacturers and Jobbers."

Officers for the coming year were chosen as follows:

President, Wm. M. Pattison, Wm. M. Pattison Supply Co., Cleveland, O.
First vice-president, A. L. Scott, Pacific Hardware & Steel Co., San Francisco, Cal.
Second vice-president, Alex. B. Pierce, N. O. Nelson Manufacturing Co., St. Louis, Mo.
Treasurer, C. G. Cornell, Jr., Cornell & Underhill, New York.
Secretary, Geo. D. McIlvaine, Pittsburg.
Executive Committee, F. A. Buckman, Nason Mfg. Co., New York; H. W. Thorndyke, F. W. Webb Mfg. Co., Boston; George B. Limbert, G. B. Limbert Co, Chicago; A. A. Merkel, Merkel Bros., Cincinnati; W. T. Todd, Somers, Fitler & Todd Co., Pittsburg; George V. Denny, Georgia Supply Co., Savannah, Ga.; J. B. Rahm, U. S. Supply Co., Omaha, Neb.; A. A. Tomlinson, Virginia-Carolina Supply Co., Norfolk, Va

The attendance included 180 members and guests.

A Tale of Three Bottles.

By E. T. Murphy.

When, some thirteen years ago, the City of Philadelphia rebuilt the old Northwest Grammar School, the engineers could hardly have foreseen the relation between the automobile and ventilation. Nor could any prophetic vision show them this schoolhouse on Race Street as being in the center of a busy motor market. Yet the three bottles here reproduced bear witness to the intimate relation of these apparently distant problems.

Fig. 1 shows the apparatus used for washing the air supplied to the school, both for heat and ventilation, and its location furnishes the plot for this tale. Just beyond the covered steam piping shown is the fresh air intake. The air, which is drawn in at this point, would be clean, healthful and bracing were it not for the automobile. It so happens that a prosperous automobile manufacturer of Detroit selected an adjacent site and there built his garage and salesrooms. Moreover, he built a driveway leading from the street into the rear of his garage within a few feet of this fresh air

FIG. 1—AIR WASHER IN NORTHWEST GRAMMAR SCHOOL, PHILADELPHIA, PA.

intake. Still prosperous, he had a steady stream of evil-smelling machines passing in and out of this driveway, some lingering there for divers and driver's reasons.

Before the installation of the apparatus for laundering the air supplied to this building the ventilating fan, with the best intentions in the world, inhaled copious drafts of the exhaust from many excited gasoline-burning motors and blew them into the school rooms. Every one interested in the welfare of this school objected, but in spite of this the automobile manufacturer in question wanted to continue doing business; hence the air washer and the memory of troubles of bygone days. Cleanliness has displaced grime, and the school again takes

FIG. 2—THE THREE BOTTLES.

an honest pride in itself. Childish hands can cling to the stair rails without later leaving a smudge on a shiny morning face, all of which brings us to Fig. 2, showing the heroes of our tale.

Their existence is due to the energy of the operating engineer who has an inquiring turn of mind. Incidentally, he wanted to prove to the health officers that the washer did wash. His method of procedure was as follows:

In bottle No. 1 he collected a sample of the dust and dirt from the fresh air intake. There was plenty of it, so he had no trouble scraping together enough to fill the gallon jar.

For bottle No. 3 he drew a gallon of the water supplied to the washer tank when he was filling it bright and early on the morning of February 6, 1913. This bottle exists to prove two things.

First: The sparkling purity of Philadelphia water.

Second: That it was this same clear water which was being supplied to the washer whenever it was necessary to wash out and refill the settling tank.

The charging of bottle No. 2 was a somewhat more elaborate process. He permitted the air washer to continue its usual operation during the six school hours of February 6, then shut it down and opened the drain-out valve. This permitted the water in the tank and all the lighter dirt to run away to the sewer. He then used an ordinary bucket, filling it with a conglomeration of dirt, carbon, oil, gasoline and water from the bottom of the tank. Apparently he had no difficulty in getting a bucketful; in fact, he says it was only a fifth of the quantity of this deposit. The washer had evidently spent a busy six hours. The various ingredients in this bucket were allowed to settle and seek their own levels. The water was then siphoned off and bottle No. 2 filled.

A study of this exhibit discloses three distinct lines in the bottle. Carbon and street dust lay claim to the greatest specific gravity and prominently occupy over two-thirds of the total space. Oil more modestly spreads a ¾-in. film over the baser mixtures and supports the condensed gasoline in the neck of the bottle. A match applied to the bottle ignited the fumes from the gasoline, much to the astonishment of the same engineer.

The utility of each of these compounds is freely admitted, but childish lungs seem to thrive without them. These bottles were placed on exhibition by a health officer, together with an explanatory card, at the National Convention of School Superintendents, recently held in Philadelphia, and seemed to arouse a great deal of interest.

Fortunately, all schools do not have to face the automobile problem with this intensity, but even the best air contains more or less floating dust, and, in our large cities, considerable quantities of soot and other impurities. Bacteria cling lovingly to wetted surfaces and can be persuaded along with soot and dust to desert the swiftly moving air and cast in their lot with the water destined in time to reach the sewer. Such affection should be and is encouraged by the modern heating and ventilating engineer.

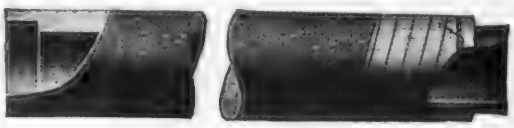
While this story tells a creditable tale of the washer's affinity for dirt and some gases, it fails to do it full justice. Nowhere is any evidence produced to show the automatic and constant regulation of the absolute humidity of the air after treatment. Yet in spite of the fact that the washer was extremely busy with its knock down and drag out battle with dirt, it did this very thing. Yes, the temperature of the wash water was varied by the action of the little thermostat and the diaphragm valves you can so plain see in Fig. 1. When Carrier conceived his fixed dew-point control, like all good engineers, he kept in

mind that a straight line is the shortest distance between two points. He wanted to vaporize water, and that needs heat, so when Nature does not furnish it, he injects some steam into the circulating water—just enough to fix the dew point of the air.

Insulation for Underground Steam Pipes.

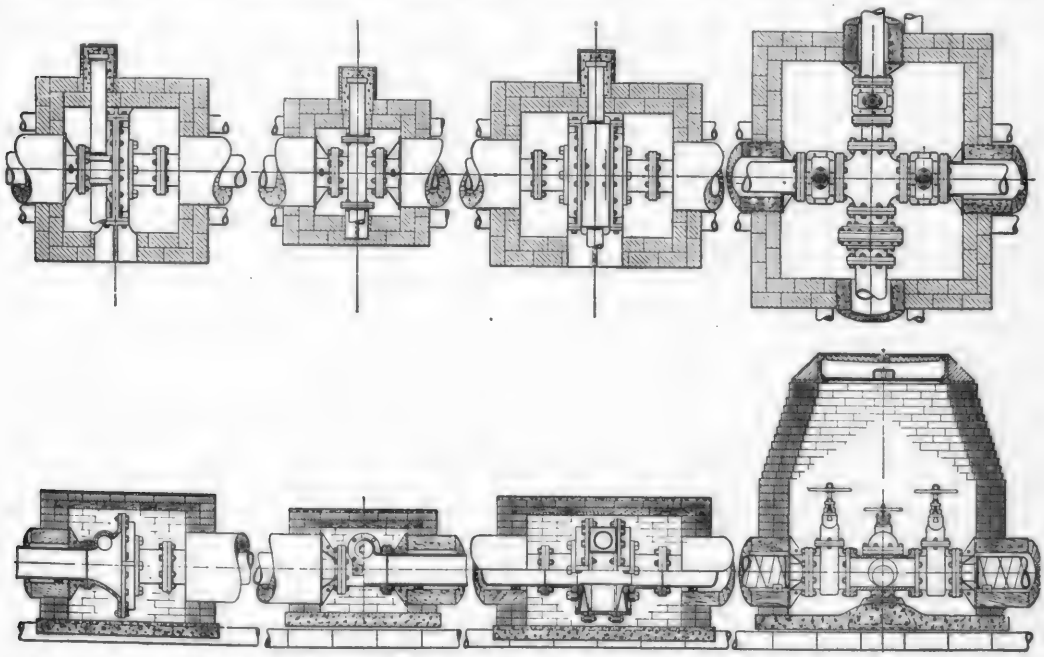
Probably no one item has figured so largely in the success or failure of central station heating plants as that connected with the insulation of the underground piping. Here the losses may easily run up to an extent that may more than counterbalance the economy and efficiency of all other portions of the system. This possibility has been realized by all connected with the industry and early led to a demand for an effective insulating material that would not only be able to withstand the heat losses from the pipes but perform the equally important function of withstanding the attacks from the outside in the shape of dampness and other conditions that might cause decay in the covering itself.

One of the early companies to approach the problem was the Michigan Pipe Company, of Bay City, Mich. As long as 40 years ago this company placed on the market a tin-lined wood covering for underground steam pipes. This covering was found to be an effective insulator, reducing the heat loss and condensation from one-quarter of 1% to three-quarters of 1% per mile of pipe delivering at capacity. The effectiveness of the covering as an insulator being early determined, the company devoted its energies to improving the casing with reference to its ability to withstand all attacks from the outside. The result is a material of notable simplicity and durability, the outside coating of which consists of asphaltum and the sections being driven together with a mortise and tenon joint after being slipped over the wrought-iron pipe. When this pipe is driven together, the casing forms a waterproof line.

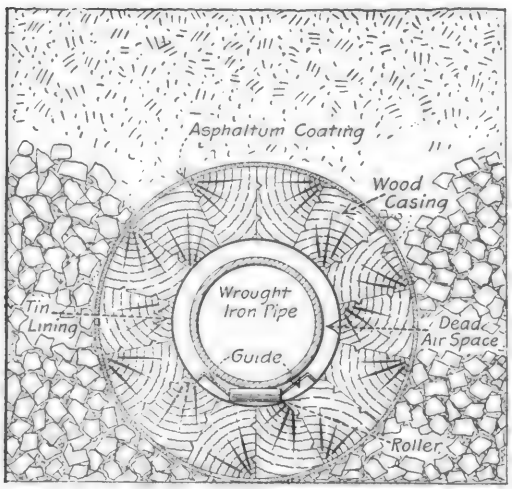


MICHIGAN UNDERGROUND PIPE COVERING.

The company's stave casings are made in 6, 7, 8 and 12-ft. sections, of seasoned pine and Michigan tamarack. The inner and outer edges of the staves are curved to conform respectively with the inside and outside circles of the pipe, and the sides are fitted with tongue and groove running the full length of the pipe. The staves, after inspection, are assembled in cylindrical form, after which the sections are spirally banded with galvanized wire from



DIASYSTOL SYSTEM OF INSULATION, SHOWING USE OF MICHIGAN TIN-LINED CASINGS, WITH A 4-IN. THICKNESS OF SHELL.



CROSS SECTION OF UNDERGROUND STEAM MAIN INSULATED WITH MICHIGAN CASINGS.

end to end under heavy tension, thus making it of uniform strength and rigid. A mortise is put in one end and tenon on the other, so that the sections can be driven together. The outer surface is then heavily coated with an imperishable cement.

The smaller sizes of casings are made of solid logs which are bored and finished in the same manner as the stave casings.

In order to hold the iron pipe concentric with the wood casing, and at the same time take care of the expansion in the wood pipe, pipe guides are furnished in sizes up to and including 4-in. without rollers, and 5-in. and up, with roller bearings.

A Flexible Coupling for Shafts.

Direct-coupled shafts in many cases need a flexible connection to save heating and wear of the bearings, vibration and loss of power, and breakage of shafts. An interesting device that meets this demand is the Francke flexible coupling, marketed by the Smith-Serrell Co., Inc., 90 West St., New York, acting as general sales agent for The Francke Co., New York. As will be seen from the illustrations, flexible steel pins (bolts) connect the two flanges which are placed on the shaft in the usual manner (except that press or taper fits are unnecessary). These pins are made of laminated spring steel leaves, held at each end by a keeper. The keepers are locked in the flanges by a snap ring. Any attendant can disconnect the

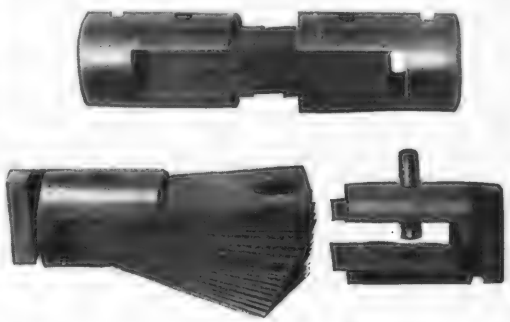


FIG. 4—FRANCKE FLEXIBLE COUPLING, SHOWING CONSTRUCTION.

coupling, yet it cannot come apart in operation. The soft steel keepers are protected from movement by short spring steel leaves at each end of the long driving leaves. The driving leaves are free to slide endwise, rock or bend in any direction to take care of the misalignment. No strain comes on the small cross retaining pins. The coupling is made for any size or speed, and for any service from slow speed stoker shafts up to high speed steam turbine shafts. It has also been used to connect fan and pumps to their driving motors, engines or steam turbines.

It is claimed that it costs less money to take two machines just as they come from

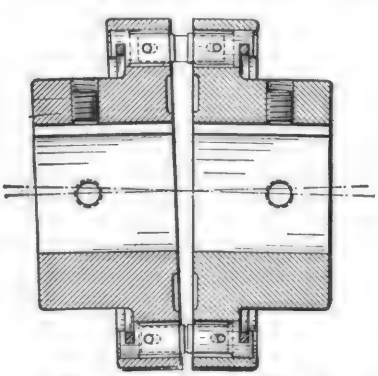


FIG. 1—SHAFTS OUT OF LINE.

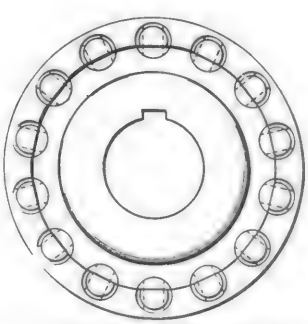


FIG. 2—END VIEW OF FRANCKE FLEXIBLE COUPLING.

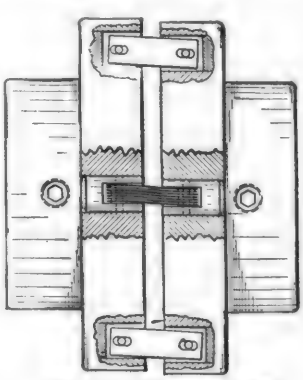


FIG. 3—SHAFTS OUT OF CENTER.

the shop and connect them up with a Francke flexible coupling than to line them up accurately enough to run successfully with a rigid coupling.

A Refrigerating Machine for Small Requirements.

A unique type of refrigerating machine, which was first offered to the public in France under the name of the Audiffren-Singrun refrigerating machine, has lately been placed on the American market to meet the demand for a small refrigerating apparatus adapted to private homes, apartment houses, clubs, cafés, hotels, hospitals, butcher shops, etc.

The machine is designed to overcome the disadvantages of high initial cost, high cost of operation, and the use of a highly-compressed refrigerant, with its attendant risk of explosion. It was also essential to simplify the mechanism so as not to require the services of an experienced engineer.

The Audiffren-Singrun machine, the construction of which is shown in the accompanying views, eliminates the use of ice. Attention is also called to the remarkable

THE AUDIFFREN-SINGRUN ICE MACHINE.

simplicity of its operation, which is controlled by a switch.

The machine works on the compression system, sulphur dioxide being used as the refrigerating agent. Sulphur dioxide is used because it can be condensed or liquefied at low pressure, thus eliminating all possibility of leaking connections, explosions, etc.

Externally, the machine is similar to a large dumb bell, consisting of two drums or globes, mounted on a hollow shaft. When these drums are revolved, the machinery within is set in motion, producing the cooling or refrigerating effect. The device is

AUDIFFREN-SINGRUN ICE MACHINE IN PRACTICAL OPERATION.

furnished completely charged and hermetically sealed, ready to be put in operation. Any form of power may be used to run it, although an electric motor is recommended.

Additional uses for the machine include the cooling of drinking water in factories and other buildings and the cooling of liquids used in various industrial processes. A very small quantity of condensing water is required. On account of its compactness, the machine can be installed in limited space.

The machine is being marketed in the United States by the H. W. Johns-Manville Co., of New York, with numerous branches, this company acting as sole selling agent. An interesting catalogue, which may be obtained from this company, gives further details of the machine and its method of operation.

New York City Master Steam Fitters' Association.

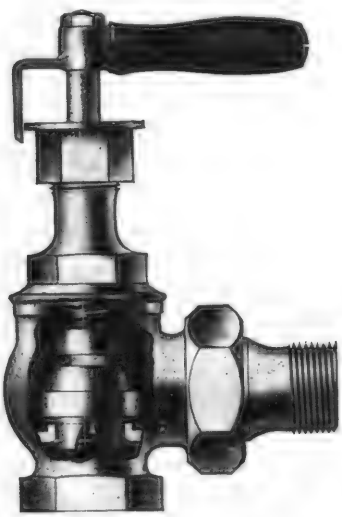
New officers of the New York City Association of Master Steam and Hot Water Fitters were elected March 25, as follows:

President, John E. Jeffery; vice-president, Joseph G. Geoghegan; treasurer, William H. Curtin; secretary, H. B. Crombers; board of directors; John E. Jeffery, Joseph G. Geoghegan, William H. Curtin, M. J. Callahan and J. E. Rutzler.

Interesting Radiator Valves.

The deserved reputation of the Jenkins Bros. heating specialties lends interest to the company's increased line of specialties, which now includes standard fractional radiator valves, for use in connection with street steam systems, atmospheric systems, vacuum return line systems and vapor systems; also automatic impulse check valves and differential check valves.

A feature of the fractional radiator valve is the construction of its graduated opening, for the partial heating of the radiator, in which its restricting orifices are so shaped that the wear, due to the wire-drawing effect of steam at high velocity, is uniform. It is so located that it will not cut the disc or seat and cause the valve to leak. The Jenkins disc gives it a tight closure when the radiator is shut off. Provision is made in its construction for a complete interchangeability of parts, giving

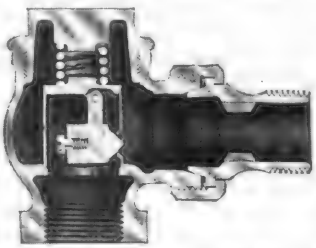


JENKINS BROS. STANDARD FRACTIONAL RADIATOR VALVE.

assurance of easy repair. The valves are furnished from ½-in. to 1½-in. and are made with or without unions, and with globe angle, off-set globe or corner valve bodies as desired.

The automatic impulse check valve is designed as a standard equipment for the return end of all radiators. It consists of a heavy brass cylinder inserted in the company's standard radiator valve body. This cylinder fits into a counter bore cut to receive it and is held in place by a spring. The seat is provided in the side of the cylinder, close to the bottom and a valve piece is swung from above in the same manner as is usual in swing check valves. The valve disc is provided with an impact surface upon which the water of condensation strikes, thereby opening the valve to its full capacity. When the supply valve of the radiator is closed, the impulse check valve prevents any return of water or steam to the radiator from the return pipe.

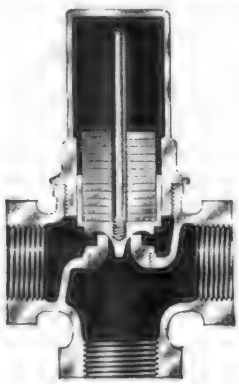
The impulse valve may be used as a return valve for the ordinary gravity system where air valves are used upon radiators.



AUTOMATIC IMPULSE CHECK VALVE.

It opens to expel the water at a low pressure, and, due to its narrow and vertical seat, is not so likely to clog up with dirt so that it will not open, nor be held open by dirt. The impulse valve may also be used as a return valve for all vacuum, vapor and atmospheric systems. When used with these systems the air may be vented from the returns by means of the company's "Guarantee" expansion air valve, or in any other suitable manner.

The differential check valves are intended



DIFFERENTIAL CHECK VALVE.

for use in the branch returns of a vacuum return line system. They are made with standard valve bodies, have a restricted seat opening proportioned to the amount of radiation they are expected to drain, and an impact surface on the valve disc similar to the impulse valve. The valve disc is also provided with a cup for holding the weights necessary to control the amount of vacuum carried. The area of the seats in all sizes of valves, and the weights, are so arranged that the brass cup will give

about 3-in. of vacuum, and each lead weight 1-in. additional. The opening in the bottom of the valve is intended as a clean-out and should be provided with a nipple and cap. All condensation should flow by gravity to the differential check valves, but it may then be lifted to the maximum height permissible by the vacuum carried. A small leakage opening is provided in the seats of the differential valves, so that the system may drain when the plant is shut down.

The main offices of Jenkins Bros. are at 80 White St., New York, while branch offices are located in Boston, Philadelphia and Chicago.

Modern Vacuum Cleaning Apparatus

7. The Spencer Turbine Cleaners.

It must be discouraging for a ventilating engineer, after he has carefully worked out a problem of supplying a building with pure air, to find the work partly undone by dust, which instead of being removed from the building, has been swept into carpets or floor cracks, only to be stirred up as soon as the occupants begin to move about. It is the province of vacuum cleaning to overcome this difficulty by completely removing the dust and dirt from the walls, carpets, floors, furnishings, etc., of buildings instead of spreading it.

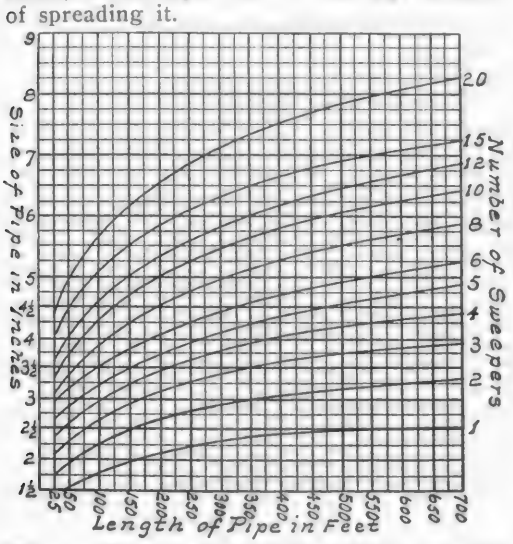


FIG. 1.—PIPING DIAGRAM BASED ON USE OF 1½-IN. HOSE FOR EACH SWEEPER.

The size of pipe used for any vacuum cleaner installation should be that given at the left of the diagram horizontally opposite the intersection of the curve for the total number of sweepers to be operated simultaneously, with the vertical line above the number corresponding to the total length of pipe from machine to the most remote inlet valve in the building.

If fewer sweepers are to be operated simultaneously through certain parts of the piping system, the size pipe for such parts can be reduced to that given in the diagram for the number of sweepers that will actually be used simultaneously, based on the same total length of pipe from machine to the most remote inlet valve in the building.

If vacuum cleaning is to make buildings a pleasanter place to live in and help new buildings to retain their newness, it must be reduced to such simplicity and everyday practicability that its use will not be limited to periodical house cleaning, but must displace the brush, broom and duster for everyday cleaning.

Cleaning tools, hose, etc., must be of such size and capacity as to handle not only dust but other small litter not easily picked up by hand. The tools must also be slim enough to reach into small corners and some provision must be made to keep the tool right side up on the floor when the handle is lowered to reach under furniture, beds, and the like.

To produce the above results, it is necessary to have a vacuum producer that will maintain at the end of the hose the right degree and the right proportion of vacuum to volume to do rapidly and efficiently **both** bare floor work and carpet work. As these proportions are quite different for the two kinds of work, it becomes a more difficult problem than appears on the surface to find a vacuum producer that will meet economically both conditions.

For bare floor work in public buildings, etc., a minimum vacuum of 2 in. of mercury should be maintained at the end of the hose while a volume represented by a 7/8-in. round open orifice is passing. Similarly for carpet work a minimum vacuum of 3 in. of mercury while a volume represented by a 5/8-in. round open orifice is passing.

It is obvious that if too small piping and hose are used, the same constant vacuum at the producer that will meet the carpet cleaning requirements, will fall fatally short on the bare floor requirements, and if too large hose and piping are used, the same constant vacuum at the machine that will meet the bare floor requirements, will be entirely inadequate for efficient carpet cleaning, to say nothing of the difficulty encountered in installing excessively large piping in buildings and the extra labor involved in manipulating large and clumsy hose.

To secure, therefore, an equipment that will meet both carpet and bare floor requirements, it is necessary not only to so design the vacuum producer that the proper proportions of vacuum to volume can be maintained, **but also** that the piping, hose

and tools be of the right proportions. One and one-half inch hose with a constant vacuum at the machine will meet both requirements perfectly, and a system of pipe sizes based on the use of 1½-in. hose for each sweeper meets both bare floor and carpet cleaning requirements and is large enough to avoid clogging and at the same time small enough to be advantageously installed in large and small buildings. (The piping diagram, Fig. 1, is worked out on this basis.)

More than nine years' persistent development of turbine vacuum cleaning apparatus has led the Spencer Turbine Cleaner Company of Hartford, Conn., to standardize the turbines and accessories shown herewith, together with a number of other refinements that experience has shown to be advantageous.

Fig. 2 shows the type of turbine which the company furnishes for residences, apartment houses and small office buildings, while Fig. 3 represents the type usually furnished for large office buildings, etc., and is the type installed in the Woolworth Building, Banker's Trust, Sloan Carpet Company, new Municipal Building, and hundreds of other similar buildings throughout the country.

Fig. 4 shows a self-closing inlet valve with concealed spring that will close the valve **in any position,** the cover being provided with a projection which holds the hose into the valve when in use.

Figs. 5 and 6 show different uses of a controllable swivel tool which enables the dirt to be reached without laborious effort in seemingly inaccessible corners, under furniture, etc.

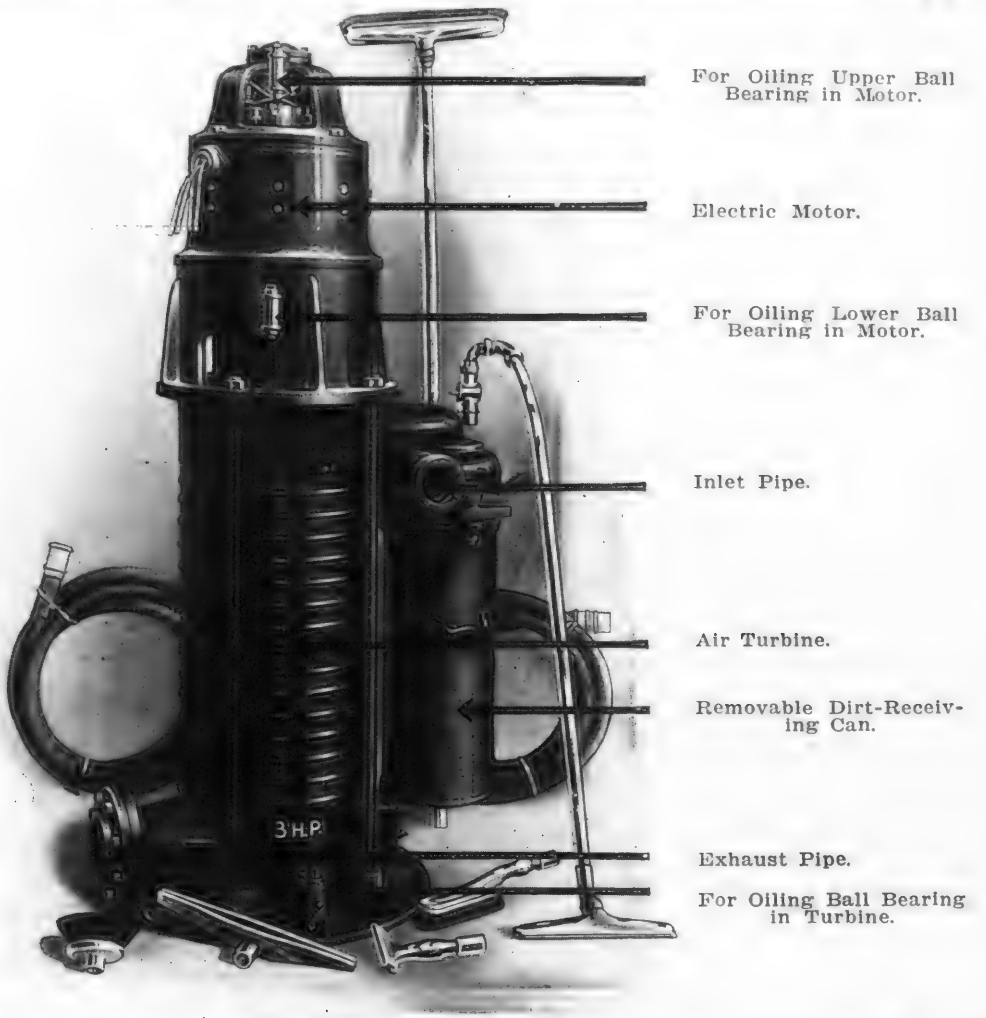


FIG. 2.—TYPE OF TURBINE USED FOR RESIDENCES, APARTMENT HOUSES AND OFFICE BUILDINGS.

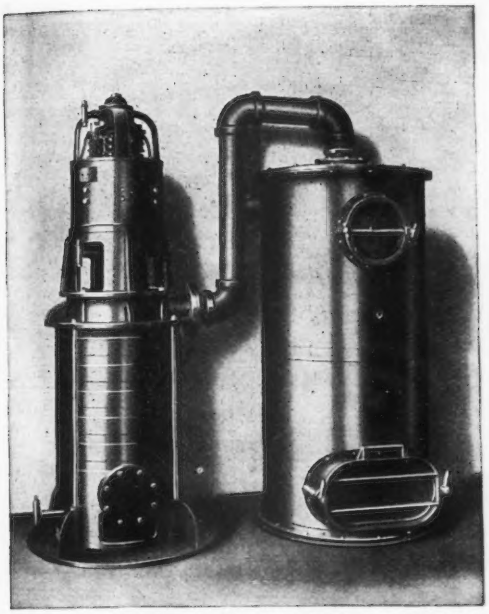


FIG. 3.—TYPE OF MACHINE USUALLY FURNISHED FOR LARGE OFFICE BUILDINGS.

Fig. 9 shows a rubber clincher hose coupling designed somewhat on the principle of a clincher tire, the object of which is to avoid the marring of floors or furniture and to provide a coupling that will not be easily bent or otherwise deranged so it will not go together.

Fig. 10 shows a ball bearing elbow joint, which makes the 1½-in. hose as easy to handle as 1-in. hose would be without it and relieves the strain on the hose at the point near the connection where experience has shown it to give out first.

One of the most useful devices in the vacuum cleaning business is the instrument called the vacometer, which enables any

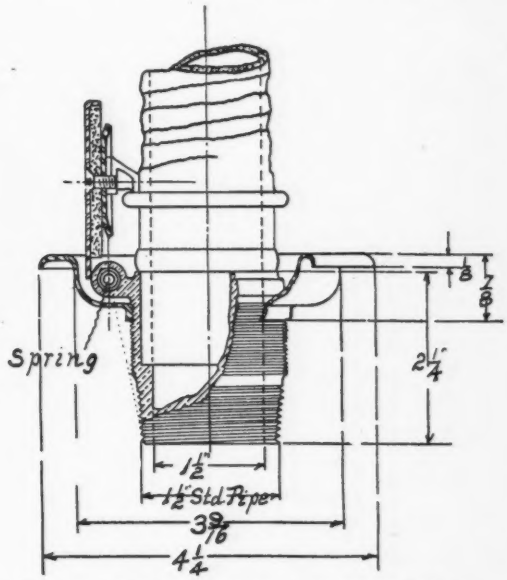
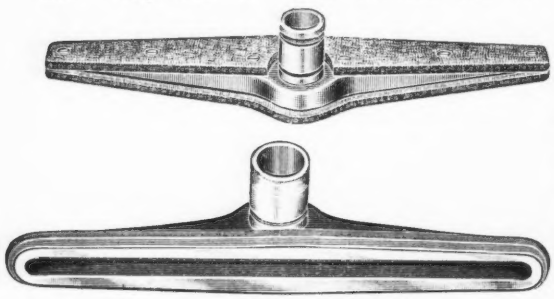


FIG. 4.—SELF-CLOSING INLET VALVE.

architect, engineer or owner to determine quickly and definitely the true sweeping value of any vacuum cleaning installation. This instrument is shown in Fig. 11 and consists of a spherical shaped chamber equipped with a hose connection on the

FIGS. 5 AND 6.—SHOWING DIFFERENT USES OF A CONTROLLABLE SWIVEL TOOL.

bottom and a vacuum gauge on the top. Around the center is a revolving cylinder carrying several different-sized orifices representing the volume of air required for different kinds of cleaning as shown by comparative tests with the tools in actual use. Any one of these orifices can be



FIGS. 7 AND 8.—PRESSED STEEL FIOOR TOOLS.

brought into use by turning the cylinder to the proper position.

This instrument makes it easy to apply the orifice test above mentioned to any vacuum cleaning system and avoids trickery in placing the vacuum gauge tube where an induced or untrue vacuum will be shown on the gauge. It also avoids expert manipulation of the tool on the floor, as has often been the case where a certain vacuum was called for at the end of the hose while the sweeping tool was in use.

Trade Literature.

Foxboro Thermometers and Thermographs is the title of an interesting treatise (Bulletin No. 73) profusely illustrated, of the line of indicating and recording thermometers made by the Industrial Instrument Co., Foxboro, Mass. This company has simplified the construction of its apparatus to a notable degree, not only in connection with the instruments themselves

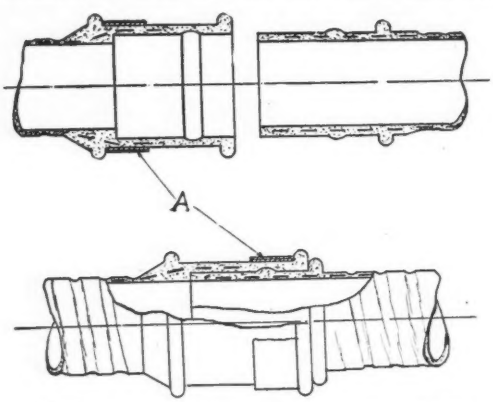


FIG. 9.—RUBBER CLINCHER HOSE COUPLING.

FIG. 10.—BALL BEARING ELBOW JOINT.

but also with regard to the clock movements (for the recording thermometers)

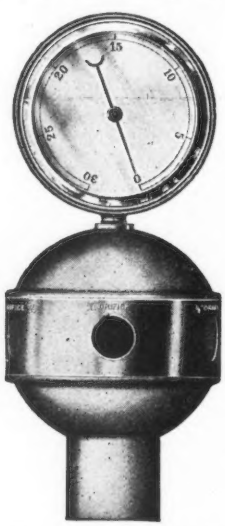


FIG. 11.—TYPE OF VACOMETER FOR DETERMINING SWEEPING VALUE OF VACUUM CLEANING INSTALLATION.

which are especially designed to add to their ruggedness and freedom from weak parts. The bulletin is supplemented with numerous chart records, which also show the dif-

ferent graduations and length of scales. Size 8x11 in. Pp. 40 (punched for binding).

Regulation of Temperature and Humidity is the title of a new and elaborate catalogue just published by the Johnson Service Co., Milwaukee, Wis., which enjoys the distinction of being the largest heat regulation company in the world. The catalogue has a frontispiece of the late Prof. Warren S. Johnson, the inventor of automatic temperature regulation. A concise and readable history is given of this branch of the art, with many illustrations, showing in detail both the features of construction and operation of the various devices making up the Johnson system. The catalogue also covers the company's line of diaphragm valves, reducing valves, pneumatic steam pressure and water level governors, dampers, damper motors, air compressors and pneumatic push buttons and switchboards. Typical installations of heating plants are included, showing the application of the Johnson system under different conditions. A special section of the catalogue is devoted to the company's automatic humidity control apparatus, including its perforated pipe steam humidifier. Photographs of many important buildings are shown equipped with Johnson systems. Size 7x10 in. Pp. 48.

Chamberlin Metal Weather Strip Co., Detroit, Mich., has opened a show room in Indianapolis, at 232 North Delaware street, where a full line of models is on exhibition illustrating the manner in which the Chamberlin weather strips are applied to different kinds and styles of windows and doors.

A STATEMENT.

Statement of the ownership, management, etc., of THE HEATING AND VENTILATING MAGAZINE, published monthly at New York, N. Y., required by the Act of August 24, 1912.

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Business Manager, Gustave Petersen, 1123 Broadway, New York.

Publisher, Heating and Ventilating Magazine Co., 1123 Broadway, New York.

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A. S. Armagnac, 1123 Broadway, New York; Gustave Petersen, 1123 Broadway, New York.

Known, bondholders, mortgagees and other security holders, holding 1% or more of total amount of bonds, mortgages, or other securities: None.

(Signed) A. S. ARMAGNAC, Editor.

Sworn to and subscribed before me this 31st day of March, 1913.

(Seal)

(Signed) A. L. SCANTLEBURY,
Notary Public No. 248, Kings County Certificate filed in New York County.
(My commission expires March 31, 1917.)

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